

U.S. Army Corps of Engineers New England District

FINAL REMEDIAL INVESTIGATION REPORT AREA OF CONTAMINATION (AOC) 57

VOLUME I OF III TEXT SECTIONS 1 THROUGH 10, FIGURES AND TABLES

CONTRACT DACA-31-94-D-0061 DELIVERY ORDER NUMBER 0001

U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DISTRICT CONCORD, MASSACHUSETTS

JUNE 2000

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DEVENS FINAL REMEDIAL INVESTIGATION

RESPONSE TO COMMENTS ON THE DRAFT FINAL REMEDIAL INVESTIGATION REPORT FOR AREA OF CONTAMINATION (AOC) 57, DATED OCTOBER 1999 DEVENS, MASSACHUSETTS

CONTRACT DAAA-31-94-D-0061 DELIVERY ORDER NO. 0001

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U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION

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<u>USEPA Comments Dated December 16, 1999</u> Comment Incorporation Response to MADEP and USEPA Comments on the Draft Remedial Investigation Report for AOC 57 dated August 1997

GENERAL COMMENTS

1. **Comment 5.** The response states that the text will be revised to include a qualitative discussion of surface water and sediment data for Cold Spring Brook. Upon review of Section 7.0, in the Draft Final Remedial Investigation (RI) Report, no qualitative discussion of the data was found. This discussion should be provided as specified.

Response: USEPA General Comment #5 (dated August 1997) requested evaluation of the risks from exposure to Cold Spring Brook surface water and sediment for a child receptor under a wading scenario. The comment further requested additional information on Cold Spring Brook to determine if the human health risk assessment (HHRA) should include an evaluation of a fishing and/or swimming exposure scenario. The response stated that a qualitative discussion of the data would be provided in the risk assessment (Section 9.0).

In light of the Supplemental Sampling conducted in 1998, surface water and sediment data at Area 2 were quantitatively evaluated for potential exposures in the HHRA and are presented in Section 9.0 of the RI. Surface water and sediment analytical data from the RI as well as previous investigations are discussed in Subsections 7.2.1.1, 7.2.1.2, 7.2.1.4, 7.2.4, and 7.2.5.

SPECIFIC COMMENTS

 Comment 9. The comment requested that the relative positions of surface water and sediment sampling locations SSD/SSW-93-06A and SSD/SSW-94-06C, relative to SSD/SSW-93-06B, be displayed. The response states that the locations of SSD/SSW-93-06A and SSD/SSW-94-06C have been added to Figure 5-3, Previous Investigation Sampling Locations. In the Draft Final RI Report, Figure 5-4, Previous Investigation Sampling Locations, SSW/SSD-93-06A, SSW/SSD-93-06B, and SSD-93-06C, are

shown. Location SSD/SSW-93-06C however, is not shown. Please review for possible typographical errors in sample location numbers in order to confirm that the figure is correct.

Response: The text reference to SSD/SSW-94-06C is a typographical error. The correct exploration should be SSD-93-06C. No surface water was collected at this location because there was no standing water. Figure 5-4 is correct.

2. **Comment 11**. The response to the comment has been incorporated into the Draft Final RI Report. However, sample number 57M-98-05X, shown on page 5-19, Section 5.4.5, is incorrect. Sample number 57M-98-05X should be changed to 57M-95-05X.

Response: The suggested change will be made.

3. **Comment 13.** The comment requested that the sequence of borings, 57M-95-04A through 57M-95-08B, be written as 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-07X, 57M-95-08A, and 57M-95-08B. The response affirms that the suggested change has been made. The suggested change was adopted in paragraph one of Section 5.4.5. of the Draft Final RI Report, but the sequence written in paragraph two (57M-95-01X through 57M-95-08B), and that in paragraph three (57M-95-06X through 57M-95-08B), should be written out to clarify the actual borings in question.

Response: The suggested change will be made.

4. **Comment 15.** The comment requested that the Aquifer Test Completion Checklist be provided in an appendix. The response states that the Aquifer Test Completion Checklists for all hydraulic conductivity testing performed are included in Appendix F. Upon review of the Draft Final RI Report, no Aquifer Test Completion Checklist was found in any of the appendices. Please add the checklist, as described in the Project Operations Plan (ABB-ES, 1995), to the report.

Response: The Aquifer Test Completion Checklists will be added to Appendix F.

5. **Comment 16**. The comment stated that hydraulic conductivity determinations were only provided for the Bouwer and Rice method. It was requested that hydraulic conductivity determinations for both the Bouwer and Rice and the Hvorslev methods be provided in Sections 6.3.1 and 6.3.2 of the report. The response states that conductivities calculated

by Hvorslev analysis will be added to these sections. Hydraulic conductivities as calculated by the Hvorslev method, however were not included in the Draft Final RI Report. Please address this omission.

Response: Hydraulic conductivity estimates as calculated by the Hvorslev method will be added to Sections 6.3.1 and 6.3.2. The Hvorslev estimates will be in addition to the existing hydraulic conductivity estimates as calculated using the Bouwer and Rice method.

6. Comment 18. The response to this comment has been incorporated into the Draft Final RI Report, but as indicated in Comment 9 above, sample location numbers may be incorrect. Section 7.2.1.2, page 7-18, refers to both SSD/SSW-94-06B and SSD/SSW-93-06B, as well as SSD-94-06C and SSD-93-06C. Please review this section along with Figure 5-4 for accuracy of sample location numbers.

Response: The text reference to SSD/SSW-94-06C is a typographical error. The correct exploration should be SSD-93-06C. No surface water was collected at this location because there was no standing water. Figure 5-4 is correct.

7. **Comment 29**. The original comment requested that methods used to characterize habitats (transect lengths, wetland area sizes, and survey methods) be described. The response states that transect lengths and estimated wetland areas will be included in Section 9.2.1 and in Figure 9-1, along with a brief description of the survey method used to categorize the wetland habitat.

The length of transects have been added to Section 9.2.1 of the Draft Final RI Report, however the other points in the comment have not been incorporated into the revised report. Wetland area information and survey method information is still missing from the Draft Final RI Report. Further, in the Draft Final RI Report, Figure 9-1, the transects are shown but lengths are not given, nor is wetland area shown. Please provide the above missing information, as detailed in the response to the comment.

Response: As indicated in subsection 9.2.1, p. 9-41, paragraph 5, HLA ecologists used a modified line transect method to complete the ecological characterization, and referenced the U.S. Army Corps of Engineers 1987 guidance for that method.

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The ecological characterization is intended to be a *qualitative* description of the habitats at AOC 57. Transects were used simply as a means of identifying the different habitats across the stream channel section (i.e., from AOC 57 upland to the opposite shore upland) for selecting appropriate receptors for the ERA; therefore, little attention was given to measuring habitat widths or transect lengths. The lengths described in subsection 9.2.1 and the transects shown in Figure 9-1 are estimated.. Given the ambiguous nature of this information, the Army has since reconsidered the value that this information would have in Figure 9-1, and therefore limited the presentation of this information to subsection 9.2.1.

The wetland areas were not measured or recorded during the ecological characterization (completed in October of 1995) or the wetland delineation (completed in October of 1993). The Army will review historical aerial photos and current maps to provide estimates of the wetland areas in subsection 9.2.1.

8. **Comment 31**. The comment recommended that risk to amphibians and reptiles be discussed in the uncertainties section. The response explains that uncertainties associated with food-chain exposure and dermal exposure for amphibians and reptiles are included in Table 9-36, Potential Sources of Uncertainty in Ecological Risk Assessment. In the Draft Final RI Report, Table 9-68, Potential Sources of Uncertainty in Ecological Risk Assessment, uncertainties associated with lack of toxicity information for amphibians and reptiles are discussed, as stated in the response.

The response also commits to clarification of Section 9.2.2.2, Identification of Exposure Pathways, to state that dermal exposure for sensitive life stages of amphibians are evaluated in the ecological risk assessment (ERA). This response was incorporated adequately into the Draft Final RI.

However, amphibians are introduced in the <u>Wildlife</u> subsection, but should be discussed perhaps in the <u>Aquatic Receptors</u> subsection as they are evaluated, along with other aquatic biota, by screening against aquatic criteria (as provided in Appendix O). Further, literature derived benchmarks for amphibians (from AQUIRE) in Appendix O, Table O-1.9, are provided for only three chemicals: 1,1,2-trichloroethylene, bis (2ethylhexyl)phthalate, and aluminum. Numerous toxicity data for amphibians, which were not incorporated into the derivation of an Effect Concentration, are available in AQUIRE and may warrant consideration.

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Response: Subsection 9.2.2.1 identifies juvenile amphibians as aquatic receptors. Subsection 9.2.2.2 under <u>Wildlife</u> describes the distinction between exposures to amphibians from contaminants in soil and surface water. Subsections 9.2.2.1 and 9.2.2.2 for <u>Wildlife</u> will be further clarified to indicate that soil exposures are relevant only for *adult* amphibians, and subsection 9.2.2.2 for <u>Aquatic Receptors</u> will repeat those listed in subsection 9.2.2.1.

Table O-1.9 represents the accumulated results of many search efforts in the AQUIRE database;, these searches were not limited to exclude certain aquatic receptors. The Army does not believe that the effort involved in conducting a new AQUIRE search would be warranted. Amphibian toxicity data obtained from other sources (Devillers and Exbrayat, 1996) included in the Final AOC 50 RI will be included in the Final AOC 57 ERA as Table O-1.10 in Appendix O. AQUIRE information for amphibians presented in the AOC 50 ERA will also be reviewed for possible inclusion in the Final AOC 57 ERA.

9. **Comment 40**. The original comment asserted that the exposure frequency of 10 days per year used for a maintenance worker should be augmented to 30 days to be more conservative. The response states that a discussion of the uncertainty associated with exposure frequency will be added to Section 9.1.6, Evaluation of Uncertainties. Upon review of the Evaluation of Uncertainties, discussed in Section 9.1.5 in the Draft Final RI Report, no discussion of the uncertainty associated with exposure frequency was found. This discussion should be added as stated in the response.

Response: The discussion was not provided in the uncertainty section because the exposure frequency for the maintenance worker was revised from 10 days per year to 26 days per year (2 times per week, April through October). Documentation of the exposure frequency is presented in the exposure factors table (Table 9-38; some pages of which were omitted during publication of the Draft Final RI, but have been included in the Final RI).

10. **Comment 43**. The comment requested that a discussion of Area 2 - Recreational Land Use exposures to subsurface soil by workers be included in the report. The response maintains that the text will be revised to state, "The interim lead screening value for residential soil (400mg/kg) was used..." Neither this quote given in the response, nor a related statement, can be found in the Draft Final RI Report. Please revise the text as stated in the response.

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Response: The referenced statement will be added. Also please note that a quantitative evaluation of construction worker exposures to subsurface soil in the wetland at Area 2 and Area 3 was included in the Draft Final risk assessment. In addition, the interim lead screening value for residential soil (400 mg/kg) was used to evaluate potential risks associated with lead in soils (see page 9-32).

11. **Comment 47**. The comment asked for enhancement of slug test information. The response stated that dimensions of the slug are provided in the Aquifer Testing Completion Checklists provided in Appendix F. In the Draft Final RI Report, the Aquifer Testing Completion Checklist cannot be found in the appendices. Please add the checklist, as described in the Project Operations Plan (ABB-ES, 1995), to the report.

Response: The Aquifer Test Completion Checklists will be added to Appendix F.

12. **Comment 59**. The comment noted that in the figure for Contaminant Pathway Model for Ecological Receptors, the term "food" is unclear and should be replaced with "biota". The response agrees to making this change in the figure, but in Figure 9-2 in the Draft Final RI Report, the change has not been made. Please change "food" to "biota", as recommended in the comment.

Response: Agreed, Figure 9-3 will be revised to show that *bioconcentration* from surface water and *bioaccumulation* from sediment in *prey items/biota*, and subsequent ingestion result in a complete exposure pathway for wildlife.

13. Comment 60. The comment requested that the exploration/sample identification for the five sediment samples collected in September 1995 be provided in Table 5-1, Summary of Investigation Activities. The response states that the suggested changes have been made. In Table 5-1 of the Draft Final RI Report, the information is still missing. Please make the change as suggested in the comment.

Response: All of the exploration location IDs are provided in Table 5-1. The additional sediment samples were from locations 57D-95-03X through 57D-95-07X where two samples, a surficial and deep (2 to 5 feet), were collected. Please refer to Section 5.4.2 for a discussion of sampling methodology.

14. **Comment 61**. The comment requested that well location for G3M-92-07X be plotted on

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Figure 6-7. The response states that, due to scale constraints, the well cannot be plotted, but that the location will be referenced in the figure. In Figure 6-7 of the Draft Final RI Report, the location is not referenced. Please reference the location of the well as stated in the response.

Response: The location of G3M-92-07X will be referenced on Figure 6-7 as requested.

15. Comment 64. The response adequately addressed the comment and was incorporated into the Draft Final RI Report. While reviewing the RI for this comment, however, some inconsistencies were discovered which should be addressed. Table 7-15 shows analytical results for groundwater. For several metals, maximum concentrations reported in Table 9-14 do not agree with concentrations shown in Table 7-15. For example, for site 57M-95-03X, lab sample number DV4F*172 concentrations for arsenic listed in Table 7-15 are 40.1 ug/L and 42.3 ug/L, but the maximum value reported in Table 9-14 is 40.1 ug/L, not 42.3 ug/L. Please review the concentrations used in Table 9-14 to determine CPCs.

Response: The arsenic concentration reported for sample DV4F*172 of 40.1 ug/L is associated with a filtered sample. As shown in Table 9-14, the maximum concentration of arsenic in filtered groundwater samples at Area 3 Industrial Use is 40.1 ug/L. Table 9-14 will be reviewed to ensure that maximum groundwater concentrations are accurately reported.

16. **Comment 65.** The comment referred to Table 9-8, Calculation of Volatilization Factors, noting that the unit "L" was not defined. The response states that the unit "L" and other units will be defined in the revised table. In the Draft Final RI Report, there is no table with the information provided in the original Table 9-8, Calculation of Volatilization Factors. Similarly, the information in Table 9-7, Groundwater Contaminant Release Analysis, in the Draft Report is not provided in a table in the Draft Final Report. If these tables were inadvertently omitted, they should be added to the revised report, with the units defined as discussed in this comment and response.

Response: Because concentrations of VOCs in groundwater at AOC 57 were very low, maximum groundwater concentrations were compared to MCP GW-2 groundwater standards (which are protective for vapor migration to indoor air at a cancer risk level of

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 1×10^{-6} and a non-cancer HI of 0.2). As shown in Table 9-21, the maximum groundwater concentrations are generally several orders of magnitude below the GW-2 standards, indicating that risks are below 1×10^{-6} and a HQ of 0.1. Therefore, the vapor migration exposure pathway was considered insignificant, and potential exposures to vapors that may migrate from groundwater to indoor air were not quantitatively evaluated in the Draft Final risk assessment. The language in Section 9.1.2.1 (page 9-18) concerning the approach used to screen this exposure pathway will be strengthened with the evidence presented in this comment response.

<u>USEPA Comments Dated December 16, 1999</u> Inadequate Responses EPA Letter to Army dated September 18, 1997 titled USEPA New England Review of the Response to Comments on the Draft Remedial Investigation Report for AOC 57

GENERAL COMMENTS

1. Comment 1. The original comment discussed the appropriateness of the data used to derive reference toxicity values (RTVs). The response to this comment indicated that the RTVs derived were sufficiently conservative, and were consistent with the approach employed at other Areas of Contamination (AOC) at Devens. This response does not acknowledge that ecological risk assessment is a rapidly evolving field. Therefore, the methods of assessing ecological risks at other AOCs in the past may not be adequate given the current understanding of ecological risk assessment procedures. According to the U.S. Army's Tri-Service Procedural Guidelines for Ecological Risk Assessment (June 1996) when LC₅₀ (or LD₅₀) data must be used to derived RTVs, a safety factor of 0.01 (or the LC50 divided by 100) should be applied rather than the value of 0.2 which was used in this risk assessment. In addition, the hierarchy of data use presented in Figure 12 of this guidance (Tri-Services 1996) should be used to select values to develop RTVs. Therefore, in all cases NOAEL data is preferred to LOAEL data, which is preferred to an LC_{50} . The RTVs should be derived using NOAEL data preferentially, and where LC_{50} data must be used, the safety/uncertainty factors applied should total to a value of 0.01.

Selected RTVs in the Draft Final RI Report are the same as those in the Draft Report. The suggestions in this comment were not incorporated into the revised report.

Response: The Army has previously responded to this USEPA comment with the following rebuttal, which was discussed with the USEPA, MADEP, and USFWS at the January 1998 meeting.

It is the Army's understanding that the *Tri-Services Procedural Guidelines for Ecological Risk Assessment* (Wentsel et al., 1996) provides a recommended method for profiling ingestion toxicity data (i.e., NOAEL, LOAEL, and LD₅₀ data), and for applying extrapolation factors to these data. This method is intended to link an RTV for a specific exposure duration to a population of receptors in the field (in order to estimate toxicity to that population within a given exposure period). The Army believes that use of these factors may seriously overestimate potential ecological risk. Although appropriate during an initial risk screening, overly conservative methodologies employed during the conduct of an ERA can result in marginalizing the importance of the risk analysis.

The primary objective of using uncertainty factors, as suggested by the reviewer and Wentsel et al. (1996), is to

derive more conservative estimates of risk (i.e., reduce Type II error). However, applying extrapolation factors does not reduce risk uncertainties. The Army believes that the approach employed in the AOC 57 ERA is sufficiently conservative. It is the Army's experience that using additional extrapolation factors as suggested by the reviewer, in the absence of a sound technical basis for doing so, can result in risk conclusions that are not supported by other lines of evidence (i.e., site-specific toxicity studies, or visual observations regarding the presence of "sensitive" species or guilds). Quantitative surveys of small mammal populations have shown that healthy populations exist at sites where the predicted risk (based on the selection of conservative RTVs) suggests that toxic conditions exist for small mammal populations.

Based on experience at other Devens and DoD sites, professional experience suggests that using LOAELs without additional extrapolation factors is less likely to over-estimate risk at a site; especially in situations (like at AOC 57) where the ecological community appears to be generally in good health. This, in turn, will likely result in realistic conclusions about risk that can feasibly be incorporated into remedial decisions (as opposed to identifying protective threshold levels at concentrations orders of magnitude less than background or upstream conditions).

The following example from the AOC 57 ERA for Area 2 Upland soil demonstrates the potential difficulties involved with using extrapolation factors:

The exposure concentration of arsenic in Area 2 soil is 21 μ g/g, which only slightly exceeds the background value for arsenic in soil (19 μ g/g). The food web model indicates that the exposure concentration of arsenic contributed to a negligible probability of risk (HQ = 1.3) for small mammals, as represented by the white-footed mouse. It is usually reasonable to assume that population level effects to native flora and fauna are unlikely at background concentrations.

The measurement endpoint selected to estimate this risk for small mammals is derived from an oral exposure study measuring reproductive effects in rats, for which an LOAEL of 0.58 mg/kgBW-day was obtained. Following the methodology outlined in Figure 12 of Wentsel et al. (1996), the chronic LOAEL would be adjusted by a factor of 5 to achieve a NOAEL:

$$0.58 \div 5 = 0.116$$

The NOAEL would then be adjusted by a factor of 16 because the white-footed mouse (*Peromyscus* sp., family Cricetidae) and laboratory rats (assuming *Rattus* sp. in family Muridae) are not in the same family:

$$0.116 \div 16 = 0.00725$$

The re-calculated risk estimate for white-footed mice exposed to arsenic in Area 2 soil now results in an HQ of 101. This suggests that there is a high likelihood that arsenic in Area 2 soil would cause adverse reproductive effects to white-footed mice, at concentrations that barely exceed background levels. If multiple conservative assumptions like these were made when selecting RTVs for all analytes, then the ERA would be needlessly conservative and broad in its identification of potential risk contributors.

The Army is aware of the advances in the field of ecological risk assessment, and on-going scientific work on the issue of toxicological extrapolations in risk analysis. Efforts have been made to develop appropriate

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uncertainty factors (UFs) for extrapolating between toxicity values for terrestrial wildlife. However, this work is still in progress, and the results presented at the November, 1996 Society of Environmental Toxicology and Chemistry (SETAC) conference suggest that there is a large degree of uncertainty associated with the use of conservative UFs. Other work presented at SETAC (EPT, 1996) suggests that applying UFs to certain data (i.e., to extrapolate from an LOAEL to an NOAEL), or using other extrapolation techniques (i.e., allometric scaling) without careful evaluation, may compound the uncertainty of an assessment.

References:

Ecological Planning and Toxicology, Inc. (EPT), 1996. Toxicity Extrapolations in Terrestrial Systems; submitted to Office of Environmental Health, Hazard Assessment, and Reproductive and Cancer Hazard Assessment Section of the California Environmental Protection Agency; Corvallis, Oregon; July 5, 1996.

In keeping with this rebuttal, the following uncertainty was added to the Draft Final AOC 57 ERA:

There is uncertainty associated with the food chain risk evaluations for wildlife, specifically associated with the selection of RTVs. Current Army guidance for conducting ERAs (Wentsel et al., 1997) suggests using NOAEL data for evaluating risks to wildlife. When NOAELs are not available, the guidance suggests applying uncertainty factors (UFs) of 10 to LOAELs, and 100 to LD₅₀s. In addition, the guidance also suggests applying other UFs to RTVs for inter-species extrapolations, and for laboratory-to-field extrapolations (effectively resulting in UFs of approximately 10,000 or more). These UFs are intended to add a degree of conservatism when evaluating risks for wildlife receptors for which specific toxicity data are lacking. While these UFs may be appropriate for use in screening-level assessments, they may add considerable uncertainty to baseline ERAs, potentially compromising the credibility of the risk conclusions and resulting in spurious remedial actions. When UFs are applied to RTVs, risk estimates for wildlife receptors may indicate a much higher potential for risk than is realistically possible. For example, UFs applied to the arsenic RTV for mortality in rats would result in a lethal HQ of 101 for the white-footed mouse, indicating a high probability of risk at background concentrations of arsenic in soil (such as was detected in Area 2 upland soil). Multiple conservative assumptions for each analyte would result in cumulative risk estimates (i.e., an HI) in the thousands. For these reasons, the Army has decided not to apply UFs to RTVs in the AOC 57 ERA; therefore, the food chain evaluation may underestimate potential risks to wildlife receptors, according to the suggested guidance.

SPECIFIC COMMENTS

1. **Comment 32**. The original comment discussed that the selected assessment endpoints were not sufficiently conservative. The response to this comment was that the most conservative data were used in generating RTVs to evaluate ecological effects. Information provided in this response should be added to Section 9.2.2.3, Identification of Endpoints, to clarify that the measurement endpoints included evaluation of sublethal effects as well as survival.

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Section 9.2.2.3, Identification of Endpoints, has not been altered from the Draft RI to the Draft Final RI Report. The suggestions provided in this comment should be incorporated into the final report.

Response: Agreed. The first paragraph of subsection 9.2.2.3 will be revised to state the following: "... is the survival and propagation of receptor populations at AOC 57. To ensure that the AOC 57 ERA is sufficiently conservative, the lowest dose for lethal (i.e., mortality) or sublethal (i.e., growth, development, or reproduction) effects were used in the ERA as measurement endpoint. The specific objectives of the AOC 57 BERA are to determine..."

2. **Comment 33**. See General Comment 1.

Response: See Response to General Comment 1.

3. **Comment 39**. The original comment discussed that, according to EPA policy, both the RME and central tendency (CT) exposure scenarios should be calculated and reported in the human health risk assessment (HHRA). The response to this comment was that, while future risk assessments will incorporate both CT and RME evaluations, no revisions will be made in this document; that is CT evaluations will not be added to the risk assessment in the present RI Report.

While the response stated that no revisions would be made in this document, CT evaluations have been included for some scenarios. CT values for Area 3 - Recreational Area, Possible Future Land Use, are included in Table 9-44, though a summary of these values is not included in the Risk Characterization Results, Section 9.1.4.2. Please add the values from Table 9-44 to this summary.

CT evaluations were also not included for the Unrestricted Future Land Use scenario for all areas. The legend in Table 9-44 states that these evaluations were omitted because only RME risks are assessed for residential exposures. This justification provided in the Draft Final RI Report is unacceptable. Under EPA policy, CT scenarios are required, regardless of exposure scenarios. Therefore, CT risks should be calculated for all exposure scenarios in this risk assessment.

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Response: The results of the CT risk characterization (shown in Table 9-44) will be added to the risk characterization discussion in Section 9.1.4.2. The rationale for excluding the CT evaluation for the unrestricted land use scenario is presented in Section 9.1.2.2., and states "CT exposures were not evaluated for the unrestricted land use scenario, since decisions regarding the possible need for land use restrictions or other actions will be based on the RME risks". Essentially, the CT scenario was omitted from the risk characterization for unrestricted land use scenario in order to streamline the risk assessment. The Army would like to discuss with USEPA what benefit would be of including the CT scenario for unrestricted land use, and how the results of the CT evaluation will be used in risk-management decision-making.

<u>USEPA Comments Dated December 16, 1999</u> Draft RI/FS Supplemental Work Plan for Area of Contamination (AOC) 57 Areas 2 and 3 Devens, Massachusetts

As a result of the review of the Supplemental Work Plan and comment incorporation into the Draft Final RI Report, the following comments appear to remain unresolved:

1. **Comment 2**. The comment requested clarification on how results from additional sampling will affect existing human and ecological risk assessments. The response stated that the additional data will be incorporated into the risk assessments. In the Draft Final RI, tables in Section 9 confirm that the additional samples have been used to establish new exposure point concentrations, as alluded to in the response. A review of tables presenting data for Contaminants of Potential Concern (Tables 9-2 through 9-4 in the Draft RI and Tables 9-4 through 9-19 in the Draft Final RI, however, reveals several inconsistencies between the Draft RI and the Draft Final RI. For example, it is unclear why aluminum in surface soil at Area 3 - Industrial Use Area was detected in 3 of 3 samples in the Draft RI but in only 2 of 2 samples in the Draft Final RI. Please explain why the number of soil samples analyzed is apparently lower in the Draft Final RI than the Draft RI.

Inconsistencies are also evident in the Maximum Detected column. For example, in Area 2 - Industrial Use Area, the maximum detected concentration for manganese in groundwater is 724 ug/L in the Draft RI but only 177 ug/L in the Draft Final RI Report. Similarly, in Area 3 - Industrial Use Area, the maximum detected concentration for lead in surface soil is 425 mg/kg in the Draft RI but only 32.7 mg/kg in the Draft Final RI Report. Please review Tables 9-4 through 9-19 in the Draft Final RI for accuracy, as they relate to tables in the Draft RI.

The comment also suggested using NOAEL based RTVs in the revised ecological risk assessment.

Response: As shown in Table 9-2, soil associated with many sample locations at Area 3 was removed during the soil removal action. Consequently, data for those sample locations were not included in the revised Draft Final risk assessment and for some analytes, such as aluminum, the data set was reduced. With respect to groundwater data, as described in Section 9.1.1.1 and shown in Table 9-3, the groundwater data selected for

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each analyte was the most recent groundwater sampling result. Tables 9-12 through 9-15 will be reviewed to ensure that maximum groundwater concentrations are accurately reported.

As discussed in response to General Comment 1, NOAEL data are more appropriate for use in a screening-level ERA, rather than in a baseline ERA. Refer to Response to General Comment 1.

2. **Comment 3.** The comment requested that total organic carbon (TOC) and grain size be included in analyses for sediment samples. The response states that TOC and grain size should be included in the analyses.

While the Draft Final RI Report, Section 5.4.2, states that TOC and grain size analyses were done on sediment samples, only TOC results were presented in the tables. Grain size distribution results are not presented. Please include these results in the report.

Response: Grain size analysis was not performed on the sediment samples collected in 1998 due to an oversight during sample collection. The text in Section 5.4.2 will be changed to reflect this.

3. **Comment 6.** The comment requested elaboration of how soil field screening results will be used to locate sediment sample locations. The response states that sediment samples will be located downgradient of areas with the highest contamination, based on data obtained from field analysis of soil samples. This discussion is not provided in the Draft Final RI Report. This explanation should be included in the Draft Final RI Report for clarity.

The comment also inquired if field screening of sediments for TPHC will be used to determine sediment sample locations. The response expresses that all sediment samples will be field analyzed for TPHC, but did not state how the results would be evaluated to determine sediment sample locations. This discussion is not provided in the Draft Final RI Report. These criteria should be discussed in the Draft Final RI Report for clarity.

Response: Text will be added to Section 5.4.2 to indicate that sediment sampling locations were selected based upon regulator input during the site walkover and using the

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field analytical data obtained during the soil sampling. As is stated in the comment and in the work plan the intent was to place sediment samples downgradient of areas with the highest levels of soil contamination.

Field analytical sediment samples for TPHC were collected concurrently with the off-site sediment samples. The field sediment samples for TPHC analysis were collected for comparative purposes and were not intended to assist in placing sediment sample locations. Sediment sample locations were determined as outlined above.

<u>USEPA Comments Dated December 16, 1999</u> Draft Final Remedial Investigation Report Area of Contamination (AOC) 57 Devens, Massachusetts October 1999

GENERAL COMMENTS:

1. Comment: Tables for each exposure scenario including the individual Chemicals of Potential Concern (CPCs) and their hazard quotients (HQs) or risk estimates should be presented in the HHRA. This type of tabular information would illuminate the risk drivers for the total risk estimates presented in the text and Table 10-1. For instance, the note on page 9-35, second paragraph, regarding the hazard index greater than 1 would be easier to put into context if the HQs for each of the CPCs and Aroclor 1260 were known (i.e., if Aroclor 1260 has a HQ less than 1, then no toxic endpoint from exposure to Aroclor 1260 would be expected).

Response: A table that shows the cancer risk estimates and hazard quotients for each COPC will be presented for each exposure scenario associated with a cancer risk greater than 1×10^4 or a hazard index greater than 1. In addition, screening hazard index values will be segregated by target organ effect to help place risks into context. Tables will not be prepared for exposure scenarios associated with a screening hazard index of 1 or less, or a cancer risk that does not exceed the USEPA risk range, because detailed understanding of the COPCs that contribute risk to these scenarios is not necessary. The tables will be prepared based on RME risk estimates, and will be presented in the risk characterization section of the HHRA.

2. Comment: The residential exposure scenario and it's exposure factors are not described in this HHRA. Exposure parameters are not discussed in the text or in the Table 9 -38 (Exposure Factors). It also appears (re: Section 9.1.6, 1st paragraph 18th line) that a surface soil exposure point was used instead of a 1 -10 feet exposure point (i.e., since there are no present residences, a future residence would need to be constructed; Risk Update number 3). This information should be added to the report and exposure parameters should be reviewed.

Response: Several pages of Table 9-38 were omitted during publication of the Draft

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Final RI Report. The missing pages will be included in the Final RI Report. For areas of the site where surface soil does not pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use (as demonstrated through a screening or segregated hazard index), risks associated with residential exposures to subsurface soil will be evaluated. For areas of the site where surface soils pose risks above the USEPA cancer and/or non-cancer and/or non-cancer risk limits for future residential use, adding a residential land use risk evaluation for potential exposures to subsurface soils (1 to 10 ft bgs) will not provide information that would change the conclusions of the risk assessment.

3. Comment: The selection of COPCs should be based upon relevant ecological benchmarks for each medium, such as ambient water quality criteria or sediment quality benchmarks. A comparison with background concentrations can be used in the selection of contaminants of concern but those background contaminants that exceed ecotoxicological benchmarks must be identified and carried through the risk assessment.

Response: Using benchmarks for selecting CPCs is consistent with the guidance described in the Process Document (USEPA, 1997) for screening-level ERAs. The Lower Cold Spring Brook Site Investigation (ABB-ES, 1995) for SA 57 (now AOC 57) included an ecological preliminary risk evaluation (PRE) that is consistent with this suggested methodology. In the ecological PRE for SA 57, nearly all maximum concentrations of chemicals detected in SA 57 sediment were identified as exceeding benchmarks; therefore, all chemicals detected in site media for the AOC 57 baseline ERA have been reported. The background screen using the established Devens background concentrations for surface soil, and the upgradient concentrations detected in Cold Spring Brook surface water and sediment, is an additional tool used for stream-lining the ERA.

For Area 2 surface water and sediment, and Area 3 surface water, the background screen was largely ineffective in removing heavy metals (i.e., non-nutrients) for further evaluation in the ERA. Manganese in Area 3 surface water was the one exception to this rule. Therefore, modifications based on this comment are, for the most part, not warranted for these media. This is not the case for Area 3 sediment, or surface soil at all three areas, where many metals were screened out as CPCs based on a comparison with the established 68th percentile background concentrations for surface soil. Rather than reorganize the baseline ERA for these media, a detailed uncertainty will be added to subsection 9.2.7 that outlines the potential risks associated with those chemicals screened out of the baseline ERA based on background or upgradient concentrations (including

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manganese in Area 3 surface water). Potential risks from RME and average concentrations of eliminated chemicals respective to risks from background/upgradient concentrations will be quantified and discussed.

The Army does not anticipate that this effort will change the existing conclusions for the baseline ERA.

Comment: Background risk can be evaluated separately from site-related risk and the discussion of cumulative, site-related and background risks should be thoroughly discussed within the risk characterization phase of the ecological risk assessment to aid in the ultimate risk management decision-making of the site. Therefore, the approach used to identify the contaminants of concern must be revised and the remainder of the ecological risk assessment modified to include any chemicals that were eliminated based solely on the background data comparison. This revision could occur with evaluating the background risks as a separate section within the assessment to eliminate the need to revise the entire document.

Response: See response to specific comment 3

4. Comment: The document "Heavy Metals in Sediments of Massachusetts Lakes and Ponds" (Rojko, 1990) was used in lieu of collecting site-specific background data for inorganic chemicals in Cold Spring Brook sediments. This reference is suitable only for evaluating chemicals for which neither risk-based screening values nor reasonable upgradient sample data are available.

Response: The Rojko (1990) concentrations of metals in Massachusetts lake and pond sediment were used *in conjunction with* the concentrations detected in upgradient sediment samples collected from Cold Spring Brook. The Rojko values were considered appropriate for use in the AOC 57 ERA because (1) there are limited upgradient data (i.e., two samples), and (2) the AOC 57 marshes at Area 2 and floodplain forest at Area 3 are depositional in nature (i.e., like lake and pond environments). These values also add perspective to the levels of chemicals that are commonly detected in sediment throughout the Commonwealth of Massachusetts.

Only those chemicals that fall within the range of "normal" lake/pond sediment concentrations were eliminated, and only two metals detected in sediment (cadmium at 2.3 μ g/g, and vanadium at 40.3 μ g/g, both at Area 2) were eliminated by this criterion

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alone. The addition of these two chemicals to the AOC 57 ERA for Area 2 sediment will have little impact on the results; therefore, the Army does not believe that the effort involved in replacing these chemicals in the ERA is warranted. Instead, these two chemicals will be included in the uncertainty described in response to comment 3.

5. **Comment:** The separate areas of AOC 57 are further divided by habitat type for the purposes of food chain modeling. This is appropriate for identifying the likely foraging frequency of the receptors in each area, however it may underestimate risk for receptors such as the barred owl or the red fox that may forage across several of the habitat types. For example, risks were calculated separately for the barred owl for Area 2 upland and floodplain soils. The problem with this approach is that the barred owl might reasonably be expected to forage in both of these contiguous areas of suitable habitat. The exposure routes and receptor species might be different between these two areas, however the risk to a single species foraging in both areas would be additive. It would seem to be appropriate to sum the risks from contiguous areas for the same species. Note that this comment would only apply to species with a site foraging frequency factor of less than one foraging across several contiguous areas. Please clarify or recalculate risks accordingly.

Response: The barred owl and red fox are the only representative wildlife receptors that may forage in contiguous suitable habitat, and that have SFFs less than 1. However, as can be seen by the HIs presented in Table 9-60, the additive risks are also not high enough to represent a potential concern to these receptors. For example:

	<u>Area 2 Upland</u>	<u>Area 2 Floodplain</u>	<u>Area 3</u>	<u>Additive Risk</u>
Barred owl (RME)	0.00021	0.00028	0.00034	0.00083
Barred owl (Average)	0.00013	0.00011	0.00017	0.00041
Red fox (RME)	0.000077	NA	0.0011	0.0012
Red fox (Average)	0.000045	NA	0.00030	0.00035

This will be addressed as an uncertainty in subsection 9.2.7.

SPECIFIC COMMENTS:

1. Comment: Page 9-6, 1st Paragraph, Section 9.1.1.1, Soil. As noted, EPA uses 0 to 1 foot to define surface soil. The logic for this choice is that this is a reasonable depth that someone might routinely be exposed (i.e., from gardening to surficial contact). Since the data collection is complete for this HHRA, please discuss in either or both the Risk Characterization or Uncertainty Sections how homogeneous the soil in the 0 to 1 foot range is to the soil in the 1 - 2 foot range (i.e., same soil type?, general consistency in analyte concentrations, etc).

Response: Soils within the 0-1 foot and 1-2 foot soil intervals are relatively homogenous. Because the contaminant release that occurred at the site was primarily subsurface, and migrated along the soil-groundwater interface (not via overland flow), it is possible that soils 1-2 ft bgs are associated with higher contaminant concentrations than soils 0-1 ft bgs. Therefore, including soils 1-2 ft bgs as "surface soils" provides a conservative assessment of potential exposures to site media. This discussion will be added to the uncertainty section of the risk assessment.

2. **Comment: Table 9-1.** Please explain why only one possibly two sample locations for Area 3 are used to estimate exposure for the recreational scenario in HHRA.

Response: Soil samples were collected at the site during field investigations and soil removal actions spread over several years. For the purposes of site characterization, the locations that were sampled were selected to define the nature and extent of site-related contamination. For the purposes of risk assessment, Area 2 and Area 3 were subdivided into industrial use areas (upland areas) and recreational use areas (wetland areas) based on current and future land uses of the site. Soil within each area was then further subdivided into surface soil (0-2 ft bgs in this risk assessment) or subsurface soil (2-10 ft bgs in this risk assessment). In the case of the Area 3 recreational use subsurface soil, there are only two sample locations in the subsurface soil exposure point. Although this number of samples could appear to be inadequate for exposure assessment, based on the objectives of the field investigations, the low number of samples actually indicates that subsurface soil in the Area 3 recreational (wetland area) is at the boundary of site-related contamination. This is further illustrated by the risk estimates calculated for potential exposures to Area 3 recreational use subsurface soil; risks are well below the USEPA risk limits, indicating that contaminant levels in the soil at this area are at levels that do not

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pose risk of concern to human health.

3. Comment: Page 9-7, 3rd Paragraph, Section 9.1.1.1, Groundwater. As described in both Region 1's Risk Update numbers 2 (8/94) and 5 (9/99), the highest temporal average for each contaminant in each well (i.e., as long as a sufficient number of samples have been collected) should be used for the exposure point. If a temporal average can not be generated, then the maximum concentration of each contaminant among all wells should be used. The ground water exposure point described in the text appears to deviate from regional guidance. In the future, the ground water exposure points should be determined in accordance with the regional guidance cited above.

Response: The groundwater exposure point concentration for each area of the site (e.g., Area 2 industrial, Area 3 recreational, etc.) is based on the maximum detected concentration from the most recent round of groundwater sampling at each wellhead in the Area. Data from the most recent round of groundwater sampling were used because historical groundwater sampling was not performed using low-flow sampling techniques, and some historical groundwater samples were collected prior to soil removal actions at the site. This approach does not appear to be inconsistent with USEPA regional guidance.

4. Comment: Page 9-24, Section 9.1.3, Toxicity Assessment. A discussion about Aroclor/Poly chlorinated byphenyl (PCB) toxicity assessment should also be included in this section. Were PCB congener analyses performed (i.e., since the tables presenting the risk estimates and HQs for each chemical/scenario are missing this is hard to ascertain; it appears that congener analyses were not completed). The regional guidance for PCB risk assessment is in Risk Update number 4 (11/96).

Response: A discussion concerning PCB toxicity will be included in toxicity profiles, which will be added to Appendix N. A discussion concerning the selection of the appropriate cancer slope factor values for evaluation of PCB toxicity will be added to the toxicity assessment section of the risk characterization. PCB congener analyses were performed on all samples collected at the site. However, only Aroclor-1248 and Aroclor-1260 were detected.

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5. Comment: Page 9-34, 1st paragraph, last line, Section 9.1.5, Evaluation of Uncertainty. Not all uncertainty is conservative.

Response: The word "conservative" will be removed from line 16.

6. **Comment: Page 9-34, Section 9.1.5, Evaluation of Uncertainty.** The discussion referenced in Section 9.1.1.3 (2^{end} paragraph) regarding background in the uncertainty does not seem to be addressed in this section. Please add this discussion.

Response: A discussion will be added that addresses the background contribution of risk for inorganic analytes that are significant contributors to site risk.

7. **Comment:** Page 9-35, 1st paragraph, Section 9.1.5, Evaluation of Uncertainty. The discussion regarding the overestimate of risk due to use of the maximum (i.e., when the 95% UCL is greater than the maximum/less than 10 samples in data set) or the use of the 95% UCL when there are one or two samples much higher in a data set is inappropriate and should be removed from the text or rewritten. The 95% UCL is the best estimate of the average exposure, when we do not have enough data to fully characterize the site (e.g., a sufficient grid sampling plan). When the 95 % UCL is greater than the maximum concentration, then the maximum is a better estimate of the true average concentration of a chemical. These tables should be added to the report and should be reviewed when they become available. Although the use of the a maximum or 95% UCL in place of a true average will add to the uncertainty, the exposure point chosen may be either higher or lower than the true average.

Response: The tables showing derivation of the exposure point concentrations have been included in the risk characterization (see Tables 9-22 through 9-37). The discussion concerning the 95% UCL will be rewritten or removed.

8. **Comment: Table 9-38.** The derivations of the adherence factors should be included in the report (i.e., either in this table or in the text). The adherence factor for the commercial industrial worker is very low.

Response: A table will be added to the report to document the derivation of the soil adherence factors.

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9. Comment: Page 9-49 Section 9.2.3 Hazard Assessment and Selection of CPCs. As noted in the general comments, the selection of COPCs is based on background concentrations. This screening is not risk-based, and may eliminate contributors to risk. Risk-based ecological benchmarks should be the primary screening tool for identifying chemicals of potential concern, with the presumption that concentrations below these benchmarks will not harm ecological receptors. It should be noted, for example, that upgradient concentrations of arsenic (110 mg/kg) exceed the Ontario Ministry of the Environment (OMOE) Severe Effect Level (SEL), and that the upgradient concentrations of copper, lead, manganese, and zinc exceed their respective Lowest Effect Levels (LELs) (Jaagumagi, 1995). All of these chemicals were eliminated as CPPCs for Area 3 sediments. While the upgradient concentrations are relevant from a risk-management perspective, they should not be used to identify COPCs.

Response: See response to General Comment 3. Potential risk from these chemicals will be addressed as an uncertainty.

10. **Comment: Page 9-53, Section 9.2.3.7** *Area 3 Sediment.* In this section the rationale was presented for using values presented by Rojko (1990) to identify CPCs in Cold Spring Brook. This reference classifies sediments according to how they compare with sediments in Massachusetts lakes and ponds, however it does not provide any measure of risk. As stated previously, COPC selection should be risk-based.

Response: See response to General Comments 3 and 5. No chemicals were screened out of the baseline ERA for Area 3 sediment using the Rojko values exclusively. Potential risks from the chemicals that were screened out of the ERA (using upgradient concentrations alone, or a combination of upgradient concentrations and Rojko values) will be addressed as an uncertainty.

MADEP Comments Dated December 30, 1999 Draft Final Remedial Investigation Report Area of Contamination (AOC) 57, Devens Massachusetts October 1999

GENERAL COMMENTS

1. a. **Comment**. Contaminants of Concern (COCs) released in Areas 2 and 3 have migrated and subsequently impacted the adjacent wetland associated with Coldspring Brook. Based on conclusions of the risk assessment, there would be unacceptable human health risks associated with unrestricted land use of soil and groundwater at AOC 57. The report subsequently recommends conducting a feasibility study to evaluate alternatives to remove potential human health risks associated with potential future potable use of Area 3 groundwater and hypothetical future residential exposures to soil and groundwater. Based on Table 7 of Appendix N *Human Health Risk Assessment*, elevated EPH hydrocarbon ranges are still detected in environmental media for surface soil/sediment).

Response: MADEPs comment is noted.

b) In the fall of 1994, the Army, USEPA, and MADEP agreed that MADEP published toxicity values would be used when EPA values are not available. Using MADEP toxicity values for those chemicals lacking USEPA published values enables quantification of risks rather than a qualitative discussion of risks for those chemicals in the uncertainty section of the risk assessment. It is recommended that this approach be used at AOC57.

Response: MADEP dose-response values for petroleum hydrocarbons (e.g., EPH and VPH) were used in the risk characterization. Available oral and inhalation cancer slope factors for all Class A, B, and C COPCs have been used. Oral RfDs published in USEPA sources have been used for all COPCs except benzo(b)flouranthene (for which a USEPA-approved dose-response value is not available). An oral RfD for benzo(b)fluoranthene will be selected in accordance with MADEP criteria, as described *in "Guidance for Disposal Site Risk Characterization* (MADEP, 1995). Inhalation RfCs are not available for three

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COPCs for which there are potentially complete inhalation exposure pathways: arsenic, dieldrin, and Aroclor-1260 (other COCPs for which inhalation RfCs are not available are non-volatile and were detected in groundwater, surface water, or sediment and, therefore, there is no complete inhalation exposure pathway). Of these COPCs, dose-response values approved by MADEP are available for arsenic and Aroclor-1260. However, the only inhalation exposure route for these two COPCs - the particulate inhalation exposure route - contributes relatively insignificant exposures relative to oral and dermal contact exposures. Therefore, using the MADEP-approved inhalation RfCs for these two COPCs would not change the conclusions of the risk assessment. Consequently, the RfCs for Aroclor-1260 and arsenic will not be incorporated into the quantitative risk estimates. However, the uncertainty associated with excluding the MADEP inhalation RfCs for arsenic and Aroclor-1260 will be addressed in the uncertainty section; the discussion will provide documentation that conclusions of the risk assessment would not change if those RfCs were used.

c) Total Site Risk - As noted in several page specific comments, when evaluating cancer and non-cancer risks for various exposure scenarios the total risk for each scenario is equal to the sum of the risks from all evaluated pathways. This exercise should be completed for all scenarios evaluated for AOC 57.

Response: Cumulative receptor risk (i.e., summation of risk among all exposure pathways and exposure media for each receptor population) was calculated for the maintenance worker, commercial/industrial worker, and recreational child exposure scenarios.

For the construction worker, cumulative receptor risk was calculated separately for surface soil and subsurface soil. Risk for each medium were not added together because risks were calculated assuming 100% exposure to each medium; adding risks together for surface soil and subsurface soil would result in doubling the assumed exposure during each day-exposed (i.e., the effective soil ingestion rate would be 960 mg/day). To accommodate this comment, risks for surface soil and subsurface soil will be added together. However, the risk for each medium will be multiplied by a factor of 0.5 prior to summation in order to reflect the assumption that a construction worker would contact both media each day, but that only 1/2 of the exposure on each day would occur at each medium.

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For the residential scenarios, cumulative receptor risks were calculated separately for soil (cumulative risk based on summation of child and adult receptor risks for exposure to soil) and groundwater (cumulative risk based on adult 30-year exposure to groundwater, per USEPA, 1994). The risk characterization (including Table 9-44) will be revised to show cumulative receptor risk for residential land use. The calculation for cancer risk will be based on the sum of the child soil risk, adult soil risk, and adult groundwater risk. The non-cancer risk will be calculated separately for the child and adult receptors. The non-cancer risk for the child receptor will be the hazard index for soil, and the non-cancer risk for the adult will be the sum of the adult soil risk and adult groundwater risk.

d) The Human Health Risk Assessment did not evaluate the exposure to subsurface soil for the residential scenario. MADEP understands that EPA Region I does not require evaluation of this pathway. However, MADEP recognizes the potential for receptors to be exposed to contaminated subsurface soil if the subsurface soils were brought closer to (or to) the surface. A qualitative discussion should be provided that addresses the possible risks present if residential exposure to subsurface soils were evaluated.

Response: For areas of the site where surface soil does not pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use (as demonstrated through a screening or segregated hazard index), risks associated with residential exposures to subsurface soil will be evaluated. For areas of the site where surface soils pose risks above the USEPA cancer and/or non-cancer risk limits for future residential use, adding a residential land use risk evaluation for potential exposures to subsurface soils (1 to 10 ft bgs) will not provide information that would change the conclusions of the risk assessment.

e) This risk assessment does not appear to evaluate the potential for the presence of hot spots. A review of the data indicates that the detected concentrations of chromium (2410 ug/g) and lead (5660 ug/g in surface soil sample 57E-95-13X in (Area 2 Recreational Use) are greater than 100 times the concentration of these analytes in surrounding samples. Since both of these are recognized as constituents of concern, it is recommended that subsurface soil sampling location

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57E-95-13X be evaluated separately as a hot spot. No other obvious hot spots were identified in this report. MADEP recommends that the data be reevaluated to determine if other hot spots exist.

Response: The identification of hot spots is an activity that is required under the MCP. Since AOC 57 is a CERCLA site, it is not clear for what purpose hot spots would be identified, or in what context they would be evaluated. The soil, sediment, and surface water exposure point concentrations used in the risk assessment were generally based on the maximum detected concentrations, because the 95% UCL was either not calculated (too few samples) or was greater than the maximum detected concentration. Therefore, analyte concentrations identified by MADEP as possible "hot spots" (e.g., 5660 mg/kg lead; 2410 mg/kg chromium) were evaluated in the risk characterization; the exposure point concentrations for lead and chromium at Area 2 recreational surface soil were based on the maximum detected concentrations identified in this comment.

PAGE SPECIFIC COMMENTS

Volume I

1. **Comment: Sec. 8.2, pg 7**. Please explain why the Fate and Transport of Contaminates section does not discuss PCBs at AOC 57.

Response: A discussion of the fate and transport of PCBs will be added to Section 8.2.

2. Comment: Fig. 7-5. Groundwater1996 field Analytical Detects Area 3, reveal elevated levels of chlorinated VOC in groundwater. Given the nature of the surficial geologic materials consisting of postglacial deposits of sands, the fact that bedrock or other confining geologic unit was not encountered in any of the borings, and the presence of dissolved chlorinated VOCs in groundwater at depth, the potential exists for dissolved chlorinated VOCs in groundwater at depth below current screened intervals of existing wells at Area 3. Based on the current groundwater analytical data, the vertical extent of chlorinated VOCs in groundwater has not been adequately defined. MADEP recommends the installation of 1 monitoring well at depth with field or laboratory GC screening of groundwater during well installation to define the vertical extent of

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chlorinated VOCs.

Response: It is true that chlorinated VOCs were detected in groundwater at or near the water table, however, the detections were approximately 1/1000th of the solubility levels for the respective compound. Likewise the levels of chlorinated solvents found in soils are insufficient to suggest a source of free product. It is also true that site soils are comprised of glacial sands and no confining units were encountered. However there is no basis for the statement that chlorinated VOCs were detected at depth. In order for chlorinated VOCs to be present below current screened intervals there would have to be either DNAPL present or downward vertical hydraulic gradients to transport dissolved phase contaminants. As discussed earlier detected levels of chlorinated VOCs are far below what would be associated with the potential presence of a DNAPL. Inference from vertical gradients at Area 2 and proximity to the persistent standing water in the wetland suggest upward vertical gradients at Area 3.

Based upon these data the Army does not feel that additional monitoring wells are warranted.

3. **Comment: Table 7-8.** This Table lists oil recovered from a trench excavated in the wetland at Area 2 had PCBs contamination of Aroclor 1254, at concentrations 28.4 ppm, Aroclor 1242, 29.7 ppm and Aroclor 1260 81.9 ppm. How much oil was removed and explain why an oil recovery system was not installed at the site to help prevent oil and PCBs from continuing to enter Coldspring Brook Wetland. Before the recovery trench was backfilled were soil samples/sediment samples collected from the trench side walls and analyzed for contamination.

Response: It is unknown how much oil was recovered from the trench during the Area 2 Removal Action. The soil removal action was believed to have removed the upgradient source of the contaminants discovered in the trench and it was agreed at the time to backfill the excavation and perform an RI/FS at Area 2. All known soil samples collected as part of the Area 2 Removal Action are provided in the RI report.

4 **Comment: Table 7-10.** Soil screening at Test pit 57E -95-15X had TPH results of 5000 ppm at 0 feet depth and at 5 feet depth 28000 ppm of TPH. In addition to TPH a laboratory confirmed analysis of 7.3 ppm of PCB 1260 was detected at a depth of 2 feet. Please explain why this petroleum and PCB impacted soil wall not excavated and removed.

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Response: The analytical results referenced were collected during the field investigation phase of the RI performed at AOC 57. The purpose of the RI was to characterize the nature and extent of contamination and to gather data to aid in the FS. It was not prudent or practical to make remedial action decisions during the field investigation phase without benefit of the full data set from the RI. Furthermore, the PCB sample referenced in the comment was analyzed at an off-site laboratory. The results of this analysis were not available until after the completion of the field investigation.

5. **Comment: Table 7-12.** Field sample location 57E-95-24X in Area 2 or 3 with a confirmed analytical of 64,900 ppm TPH the location of this sample could not be located on the figures. MADEP request the location and depth of this sampling site be shown on the figures and discuss in the report whether the impacted soil was removed.

Response: Test pit 57E-95-24X is located at Area 3 (refer to Table 7-12) within the center of the historical disposal area. The test pit is located at the center of the radial array of test pits 57E-96-29X through 57E-96-31X and is shown on Figures 7-3 and 7-4. This soil was removed during the 1999 Area 3 Soil Removal Action which is discussed in Section 7.3.

6. **Comment: Table 7-15.** Elevated levels of Arsenic in groundwater have been confirmed at AOC 57. MADEP anticipates the future ROD for AOC57 to limit the use of groundwater at the site.

Response: MADEPs comment is noted.

7. **Comment:** Pg. 9-19, para 4. This paragraph states that groundwater data collected from AOC 57 was compared the MCP Method 1 risk-based standards to evaluate the potential migration to indoor and ambient air. This procedure is inappropriate as part of a baseline risk assessment. The purpose of a quantitative baseline risk evaluation is to look at the cumulative effects of known/potential exposures via various environmental media looking at site-specific conditions. Both USEPA and MADEP risk guidance calls for demonstrating that indoor and ambient air is or will not be affected by contaminants in shallow ground water, which may be achieved by indoor air sampling, soil gas studies, or fate and transport modeling. This exercise should be completed for AOC 57.

Response: Because concentrations of VOCs in groundwater at AOC 57 were very

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low, maximum groundwater concentrations were compared to MCP GW-2 groundwater standards (which are protective for vapor migration to indoor air at a cancer risk level of 1×10^{-6} and a non-cancer HI of 0.2). As shown in Table 9-21, the maximum groundwater concentrations are generally several orders of magnitude below the GW-2 standards, indicating that risks for the vapor migration pathway are below 1×10^{-6} and a HQ of 0.1. Therefore, the vapor migration exposure pathway was considered insignificant, and potential exposures to vapors that may migrate from groundwater to indoor air were not quantitatively evaluated in the Draft Final risk assessment. The language in Section 9.1.2.1 (page 9-18) concerning the approach used to screen this exposure pathway will be strengthened with the evidence presented in this comment response.

8. **Comment: Pg. 9-20, para 4.** For cancer and non-cancer risks, various pathways are assumed to be additive, as long as the risks are for the same individuals and time period. The risks summarized in this section should evaluate the combined risks calculated for both the surface soil and subsurface soil for the construction worker. The combined risks should then be compared to the acceptable cancer risk range and non-cancer limit (HQ).

Response: Please see the response to General Comment C.

9. Comment: Pg. 9-30, para 5. See Comment to page 9-29, paragraph 4.

Response: See response to Comment to page 9-29, paragraph 4.

10. **Comment: Pg. 9-31, para 2**. As discussed in the comment to page 9-29, paragraph 4, cancer and non-cancer risks for the various pathways are assumed to be additive. The cancer risk summarized in this section should evaluate the combined risks calculated for both the adult (surface soil and groundwater) and child (surface soil). The combined risks should then be compared to the acceptable cancer risk range.

Response: Please see the response to General Comment C.

11. Comment: Pg. 9-31, para 5. The central tendency cancer risk value was identified as equal to 3×10^{-6} in this section. According to Table 9-44, it is 3×10^{-7} . Verify which number is correct and make appropriate changes.

Response: The correct value is 3×10^{-7} ; the text will edited accordingly.

12. Comment: Pg. 9-32, para 3. See Comment to page 9-29, paragraph 4.

Response: See response to Comment to page 9-29, paragraph 4.

13. Comment: Pg. 9-32, para 4. See Comment to page 9-31, paragraph 1.

Response: The CT cancer risk is 5×10^{-5} ; the text will edited accordingly.

14. Comment: Pg. 9-33, para 3. See Comment to page 9-29, paragraph 4.

Response: See response to Comment to page 9-29, paragraph 4.

15. Comment: Pg. 9-33, para 5. See Comment to page 9-31, paragraph 1.

Response: The CT cancer risk is 9×10^{-6} ; the text will be edited accordingly.

16. **Comment: Pg. 9-50, para 1.** The text states that the process for selecting sediment contaminant of potential concern is based on "background" data collected from lakes and ponds in Massachusetts. It is unclear how this data set for lakes and ponds represents "background" concentrations for Cold Spring Brook. If analytes are to be eliminated as CPCs based on "background" concentrations, then the "background" concentrations need to reflect upgradient concentrations within the same waterway. Sampling data from upstream locations in Cold Spring Brook should be used in place of regional lake and pond data for the selection of contaminants of potential concern at Cold Spring Brook

Response: See response to General USEPA Comment 5.

17. Comment: Pg. 9-53, para 3. See Comment to page 9-50, paragraph 1.

Response: See response to General USEPA Comment 5. Only cadmium and vanadium in Area 2 sediment were screened out of the ERA using the Rojko values; these will be addressed in an uncertainty.

18. Comment: Pg. 9-53, para 4. See Comment to page 9-50, paragraph 1.

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Response: See response to General USEPA Comment 5. There are no metals in Area 3 sediment screened out as CPCs using the Rojko criteria exclusively. Chemicals screened out of the ERA using upgradient concentrations alone, or a combination of upgradient concentrations and Rojko values, will be discussed as an uncertainty.

19. **Comment:** Pg. 9-67, para 1. The RI states that the arsenic Reference toxicity value (RTV) is conservative for the muskrat. Please provide justification to support this statement such as comparing this RTV with other RTVs available in the literature (e.g., Sample et al., 1996). In addition, additional discussion should be provided to support the statement that adverse effects to small mammals (represented by the muskrat) from detected lead and manganese concentrations within Area 2 surface water and sediment are unlikely.

Response: Additional discussion will be provided regarding the statement that the selected RTV for arsenic is conservative. As discussed in the last sentence of paragraph 1 on p. 9-67, the rationale that small mammals are not likely at risk from lead and manganese in Area 2 surface water and sediment is justified by the finding that the estimated exposures only slightly exceed the conservative RTVs.

20. **Comment: Table 9-44** According to Table 9-44, a Receptor Total was not calculated for the Possible Future Land Use - construction worker (surface and subsurface soil) and for the Unrestricted Future Land Use - residential (adult surface soil, child surface soil, and adult groundwater). The individual cancer and non-cancer (except for residential) risks should be summed to yield a Total Receptor Risk. The Total Receptor cancer and non-cancer risks are then compared to EPA's acceptable cancer risk range of 1E-04 to 1E-06 and the non-cancer HQ of 1. This table needs to be corrected to show the cumulative receptor cancer and non-cancer risks.

Response: Please see the response to General Comment C.

21. Comment: Table 9-58 A soil:plant bioaccumulation factor (BAF) of zero was assigned to lead based on a reference (Levine et al., 1989) that suggests lead does not bioaccumulate in plant tissue. However, references (Boggess, 1977; Behan et al., 1979; and Jenkins, 1980) cited in Eisler (1988) suggest otherwise. It seems prudent to use a bioaccumulation factor as provided in Baes et al. (1984) in a baseline characterization.

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Response: The Army will review the Eisler document; it is possible that the data cited in Eisler (1988) are based on organo-lead values, which would not be appropriate for the AOC 57 ERA. If this is the case, then the Army does not believe that a change to the lead BAF is warranted. If the Eisler document suggests that inorganic lead may bioaccumulate in plants, then a BAF of 0.009, based on the Baes (1984) plant BTF of 0.045 multiplied by a factor of 0.2 (assuming 80% plant water content), would be incorporate in the Final baseline ERA for AOC 57. However, this change will likely have little impact on the AOC 57 ERA conclusions.

22. **Comment:** Table 9-38. According to paragraph 3 on page 9-21, information pertaining to the parameters used in current/future use, possible future use, and unrestricted future use scenarios should be provided in this Table. Parameters are presented for only the possible future land use: commercial/industrial and construction workers.

Response: Several pages of Table 9-38 were omitted during publication of the Draft Final RI Report. The missing pages will be included in the Final RI Report.

23. **Comment: Table 9-64** Ambient Water Quality Criteria (AWQC) are presented for unfiltered and filtered surface water sampling results. It should be noted that AWQC are available (Federal Register, December 10, 1998) for dissolved (i.e., filtered) surface water constituents. These values should be used for the filtered metals. Please correct the table accordingly.

Response: Agreed. The differences between the hardness-adjusted AWQC for filtered and non-filtered metals are negligible; therefore, it is expected that there will be no impact on the ERA conclusions.

24. **Comment: Table 10-2** This table does not indicate that small mammals may be at risk from detected concentrations of some metals within the sediments of Area 2. See comment 5. Please revise the table if appropriate.

Response: See response to comment 19. No additional metals need to be added to Table 10-2. The Army is unclear about the MADEP's reference to comment 5.

25. **Comment:** Table O-1.1 An exposure duration of 0.75 and 0.5 are presented for the American robin and great blue heron, respectively. It is unclear why the exposure

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duration for these species is not 1.0 (as it is for the mallard and the remaining species). Unless the sub-lethal reference toxicity values (RTVs) for the American robin and great blue heron are based on studies conducted for one year or more, it is appropriate to use an exposure duration factor of 1.0 as their length of exposure (i.e., the breeding season) is likely to exceed the exposure duration in the RTV study. Please reassess risk to these two species using an exposure duration factor of 1.0.

Response: The Army's purpose for selecting EDs less than 1 for the robin and heron are based on the percentage of the year that they are expected to forage at AOC 57. Herons are only expected to forage at AOC 57 for one-half of the year because of migration; they are unable to forage in the AOC 57 area during wintertime frozen conditions. While robins are around all year, their wintertime diet consists primarily of berries; they do not forage in soil for earthworms or other invertebrates during the wintertime, thus reducing their direct and indirect soil exposures. This will be explained in the notes of Table O-1.1 in Appendix O.

The Army agrees with the reviewer's point that the length of exposure for wildlife species (i.e., the breeding season) may be the same as or longer than the duration of some laboratory studies on which the RTVs are based. By assuming EDs of 1 for both of these receptors, the estimated risks for the robin would increase by 33%, and estimated risks for the heron would be doubled.

Mercury accounts for most of the estimated risk to herons; risks to the heron and robin from exposure to other chemicals were otherwise negligible. A 33% increase in the risk estimate for the robin or a 100% increase in the risk estimates for the heron for chemicals other than mercury would have no impact on the risk conclusions for AOC 57.

The mercury RTV is based on a reproductive behavior study on mallards; however the exposure duration for this study is not reported. The Army will determine the exposure duration, and if it is less than 1 year, an uncertainty will be added to subsection 9.2.7. A discussion of other uncertainties will also be included, such as the implications that bodyweight scaling would have, and the questionable risks from mercury in AOC 57 surface water and sediment.

If the mercury RTV was adjusted by body weight scaling factors for the mallard and heron, then the RTV used to estimate risks to the heron would likely be much lower. This would likely counter the effect of doubling the heron's ED. In addition, the risks

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associated with mercury at AOC 57 are questionable because (1) the majority of risks are based on unfiltered surface water sample results from one highly turbid sample (mercury was not detected in the filtered sample), and (2) mercury was detected in only one sediment sample that was not collected in close proximity to the disposal area.

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26. Comment: Appendix N, Table 7 Samples EX57W14X, EX57W15X and EX57W16X soil samples revealed elevated petroleum contamination in the EPH ranges of C9 - C8, C19-C32, Aliphatics and C11- C22 Aromatics. These samples were taken from the open excavation in the immediate area of the Coldspring Brook wetland at Area 3. They represent samples of the impacted soil remaining at the site. Explain why TPH analysis was not conducted at the above noted sample locations and what reasons this contaminated soil was left in place.

Response: It is assumed that the commentor is referring to TPH analysis as a screening tool and not as an off-site analysis. As was stated in the Removal Action Memorandum (February, 1999) and the Response to Comments on the Removal Action Memorandum (February, 1999) screening of soils was performed with a PID. Based upon results of the off-site confirmatory sampling additional excavation was performed to attain the proposed cleanup goals.

Three separate excavations were performed to eliminate as much of the soil contamination as possible. The residual contamination detected in the last phase of confirmatory sampling was incorporated into the RI risk assessments.

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<u>CX Comments Received January 7, 2000</u> Draft Final Remedial Investigation Report Area of Contamination (AOC) 57, Devens, Massachusetts October 1999

Risk Assessment Comments: Meyer

1. **Comment:** 482483-1068 The document frequently refers to "USEPA requirements for site closure, a no further action decision must be supported by the demonstration that a site does not pose an unacceptable risk for future unrestricted land use". Though this statement is not inconsistent with the NCP if it is based upon written guidance it should be cited in the RI document. The text as stated seems to be a strict interpretation of OSWER directive 9355.7-04 "Land Use in the CERCLA Remedy Selection Process" (1995).

Response: The statement is not based upon known written guidance. This practice has been mandated by USEPA Region I and personally communicated to the Army.

Toxicity Assessment

2. **Comment: 482483-1069** Recommend adding uncertainty discussion regarding the RfDs for EPH and VPH. These are not EPA approved toxicity values and these are based upon surrogate toxicity values for a range of hydrocarbons. There is considerable uncertainty associated with the values which warrants discussion.

Response: An uncertainty discussion regarding use of the MADEP dose-response values for EPH and VPH will be added to the section.

3. **Comment:** 482483-1070 Since there are HIs above 1 which are leading to recommendations for further study in an FS, recommend that the organ specific effects be segregated and discussed.

Response: Hazard index values will be segregated by target organ effect for exposure scenarios associated with a screening hazard index value greater than 1. For some

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exposure scenarios that have screening hazard index values greater than 1, the segregated HI will likely demonstrate that risks are below the USEPA threshold HI of 1 (e.g., child resident at Area 2 upland). For other exposure scenarios that have screening hazard index values greater than 1, there is a single COPC that has a hazard quotient greater than 1 (e.g. Aroclor-1260 in the Area 2 wetland has a HQ greater than 1 for the construction worker and residential scenarios). Therefore, the segregated HI will not necessarily demonstrate that risks are below the USEPA threshold HI of 1, but will likely demonstrate that risks are due to a single chemical of concern.

4. **Comment:** 482483-1071 The exclusion of the inhalation pathway for VOCs needs to be better justified. Stating that sandy soils and warm days in the present tense would not contribute to a complete exposure pathway does not make sense. However, sandy soils would lead to decreased concentrations over time for spills that happened in the past. Recommend focussing on the low concentrations of VOCs found during the RI investigation and using this as justification for VOCs being an insignificant contributor to risk. Additionally there is a lack of inhalation toxicological data for wildlife, this could also be used as a justification for excluding the pathway.

Response: Agreed.

5. **Comment: 482483-1072** The recommendation for soils at Areas 2 and 3 to proceed to an FS did not carefully consider the data and all elements of the risk assessment:

Given the uncertainties associated with the toxicity and exposure parameters used in the risk assessment and that the HI for soils were 2 and 4 for the industrial and recreational areas respectively, a reasonable risk management decision for the soils at Area 2 would be no further action. Segregation of organ specific effects may further support this decision.

Segregation of organ specific effects should also be performed for Area 3 soils. This may also support an NFA for this area, but also the fact that the unacceptable HI for the recreational area is 3 and is only based upon 2 samples could justify an NFA for this area.

If the groundwater at Areas 2 and 3 does proceed to an FS, recommend that it focus upon institutional controls that would be needed in addition to the groundwater classification.

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Response: The Army has received specific instruction from USEPA to exclude risk management/site closure language from the risk characterization and RI Report. Please see the response to comment on section 9.1.4.2 regarding hazard index segregation.

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Prepared by:

Harding Lawson Associates Portland, ME Project No. 45001 Task No. 0914403

June 2000

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Harding Lawson Associates (HLA) has prepared this Remedial Investigation (RI) Report on Area of Contamination (AOC) 57 to support Task Order 001 of Contract DACA-31-94-D-0061 under the oversight of the U.S. Army Corps of Engineers - New England District. This RI Report details the results of the RI and previous investigations completed at AOC 57 Areas 1, 2, and 3.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, and was officially closed in September 1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens Reserve Forces Training Area (RFTA). Areas not retained as part of the Devens RFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment. AOC 57 is located in an area planned for transfer to the Massachusetts Government Land Bank for industrial/trade related development and recreation/open space.

SITE CONDITIONS

AOC 57 consists of three subsites, Areas 1, 2, and 3, located to the southeast of Barnum Road on what was formerly the Main Post (Figure ES-1). A storm water drain that collects rainfall from the paved areas around Building 3713 has been designated as Area 1.

Area 1 was investigated and addressed as part of the Groups 2 & 7 Site Investigation (SI) (ABB-ES, 1995a), the Area Requiring Environmental Evaluation (AREE) 70 (ADL, 1995) investigation, the Lower Cold Spring Brook SI (ABB-ES, 1995c), and the Study Area (SA) 57, Area 1 Contaminated Soil Removal (Weston, 1998). Following the 1997 contaminated soil removal, Area 1 was recommended for no further action; the decision is to be formalized in the AOC 57 Record of Decision. In accordance with recent USEPA requirements for site closure, a no further action decision must be supported by the demonstration that a site does not pose an unacceptable risk for future unrestricted land use.

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Area 2 previously consisted of an eroded drainage ditch created by periodic precipitation runoff from a vehicle storage yard; however, following a 1994 removal action the area was regraded and a stone drainage swale installed which discharges into Cold Spring Brook. During the removal action it was discovered that the soil and groundwater contamination were more widespread than expected. The soil removal was stopped and AOC 57 Area 2 was administratively transferred to the RI/FS process. Area 3 is located approximately 600 feet to the northeast of Area 2, south of vehicle maintenance motor pools and north of the Cold Spring Brook floodplain. The site is characterized by an historic garage and vehicle waste disposal area. The focus of the RI was on Areas 2 and 3.

In general, the efforts associated with this RI have resulted in conceptual models that identify the sources of groundwater contamination at Areas 2 and 3 as contaminated soils above and in the water table. Contaminated soils at Area 2 are believed to be due to the historic disposal of vehicle maintenance related waste. Data acquired during the RI and previous investigations indicates that the soils in the vicinity of the soil removal excavation are the source of Area 2 groundwater contamination. The Area 3 contaminant source area was delineated by test pitting and consists of a former vehicle maintenance waste disposal area approximately 5 feet in depth and 40 feet square in the vicinity of test pit 57E-95-24X.

Detected Area 2 contaminants are comprised primarily of toluene, tetrachloroethene (PCE), trichloroethene (TCE), and naphthalene in soil and groundwater as well as PCBs and TPHC in surficial and subsurface soils. Reducing conditions caused by the contamination have also created elevated levels of naturally occurring arsenic in groundwater. The soil and groundwater contamination is located around the southern perimeter of the soil removal excavation from the ground surface to the water table at approximately 4 to 5 feet bgs. Low levels of site related contaminants detected in surface water samples confirm that Area 2 groundwater is discharging to the Cold Spring Brook wetland. Analytical data further indicates that Area 2 is not impacting the downstream portion of Cold Spring Brook. Distributions of TPHC, arsenic, and other inorganics within the Cold Spring Brook stream channel suggest an alternate upgradient source of these analytes. Elevated concentrations of TPHC, arsenic, and lead were detected in the area of the brook upstream from Area 2.

Detected Area 3 contaminants are comprised primarily of toluene, PCE, TCE, naphthalene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, PCBs, and TPHC. Soil contamination appears to have migrated south from the source area by advective groundwater transport and sorption. Groundwater contamination has been observed from the source area 175 feet

south to the downgradient piezometer 57P-98-03X. Similar to Area 2, reducing conditions caused by the degradation of petroleum contaminants at Area 3 have resulted in elevated levels of naturally occurring arsenic in groundwater. A source area soil removal conducted by the Army in 1999 has eliminated the bulk of the soil contamination at Area 3. Residual EPH, PCB, and pesticides contamination remain in soils near the southern end of the excavation. Surface water and sediment sampling show low levels of contaminants present near the southern end of the removal excavation but not further into the wetland.

Human Health Risk

Possible health risks were evaluated for the current land uses, anticipated future land uses, and unrestricted future land uses at AOC 57. Although the site is presently not used for any specific purposes, and is not located near any properties with active land uses, exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use. Therefore, the possible health risks associated with future use of the wetland area of the site were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment) as well as a construction worker (possible exposure to surface soil and subsurface soil). In addition, to aid in risk management decision-making and to determine if additional response actions may be required at AOC 57, future unrestricted land use was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil, subsurface soil, and groundwater). Since groundwater at and beneath AOC 57 is not used as a source of drinking or industrial water, and is not considered a groundwater resource by the State of Massachusetts, evaluation of potable groundwater use represents a hypothetical worst-case evaluation of potential exposures and risks.

The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern identified in surface soil and subsurface soil primarily included arsenic, iron, manganese, PCB, and petroleum compounds such as

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EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations. Petroleum compounds and PCBs are interpreted to be directly associated with the release of oils and vehicle maintenance wastes to soils at the site. Inorganic constituents selected as CPCs are interpreted to be indirectly associated with the petroleum release. The natural degradation of petroleum contaminants has caused reducing conditions at the aquifer, which in turn results in enhanced leaching of naturally-occurring inorganics from source area soils.

Possible health risks were quantified for carcinogenic and non-carcinogenic effects, for both reasonable maximum and central tendency exposure assumptions. Table 9-44 and Table 10-1 present a summary of the risk estimates. Estimated cancer and non-cancer risks associated with current land use conditions are within acceptable levels established by the USEPA (defined as a 1x10⁻⁴ to 1-10⁻⁶ excess risk). Estimated cancer and noncancer risks associated with future open space use of the wetland areas of the site were within acceptable levels established the USEPA. However, estimated non-cancer risk for potential effects to the immune system exceed a hazard index (HI) of 1 for a construction worker exposure to Area 2 wetland subsurface soil. An HI of 1 is the threshold value typically applied by the USEPA to evaluate the significance of non-cancer risk. These non-cancer risks were primarily attributable to PCBs detected in soil samples at the toe of the Area 2 soil removal excavation. With the exception of potable use of Area 3 groundwater, estimated cancer and non-cancer risks associated with future commercial/industrial development and use of upland areas of the site were within acceptable levels established by the USEPA. The estimated cancer and non-cancer risks for commercial/industrial potable use of groundwater at Area 3 exceeds levels considered acceptable by the USEPA. Since groundwater at AOC 57 is not considered a potable water resource, potable use exposures are unlikely to occur. A more realistic potential use of AOC 57 groundwater is for industrial process water. It is unlikely that non-potable industrial uses of groundwater would result in an exposure scenario which would result in unacceptable levels of risk.

Estimated cancer and non-cancer risks associated with unrestricted land use exposures to soil by a hypothetical child or adult resident at upland portions of Area 2 and Area 3 do not exceed levels generally considered acceptable by USEPA. Estimated cancer risks for child and adult resident exposures to soil in the wetland portions of Areas 2 and 3 likewise do not exceed the USEPA risk range. However, non-cancer risks to a child

resident potentially exposed to soils at these areas exceed target organ-based HI values of 1. At the Area 2 wetland soils, the principal risk contributors are arsenic, aroclor-1260, chromium, and C11-C22 aromatic EPH. For Area 3 wetland soils, the principal risk contributor is C11-C22 aromatic EPH.

With the exception of the upland portion of Area 2, estimated cancer and non-cancer risks for potable consumption of groundwater at AOC 57 exceed the USEPA Superfund cancer risk range and a HI of 1. However, due to the fact that groundwater at AOC 57 is not considered a groundwater resource by the State of Massachusetts, and the availability of public water supply at Devens, it is unlikely that groundwater beneath AOC 57 will be used as a source of potable water in the future.

The soil removal actions at AOC 57 significantly reduced petroleum contamination in soil, thereby mitigating possible exposures to petroleum-related CPCs and mitigation the leaching of naturally occurring inorganics. Therefore, the risk estimates presented in this risk assessment are worst-case estimates that are unlikely to be exceeded under conceivable future land use conditions.

Ecological Risks

Potential risks for ecological receptors at AOC 57 were evaluated for CPCs in surface soil, surface water, sediment, and groundwater using benchmarks from the literature and site-specific data (e.g., toxicity test results, bioaccumulation study results, and measurement of fish and crayfish tissue concentrations). The following exposure pathways were evaluated in the BERA:

- food chain risks to terrestrial and semi-aquatic mammals and birds that occur in the upland, forested floodplain, and open stream/marsh areas;
- direct contact risks to aquatic receptors (e.g., plants, invertebrates, amphibians, and fish) exposed to surface water and sediment; and
- direct contact risks to terrestrial plants and soil invertebrates exposed to surface soil.

The following summarizes the results of the AOC 57 BERA:

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- mercury was detected in only one unfiltered surface water sample (at Area 2), and not at all in filtered surface water. The detection in the one unfiltered sample raises uncertainty about the bioavailability of mercury in Area 2 surface water. There are also doubts about the origin of mercury in the one sediment sample in which it was detected. These factors create significant uncertainty regarding the conclusion of the BERA that wading birds may be at risk from exposure to mercury from Area 2 surface water or sediment that may bioaccumulate in fish tissue;
- a survey of Area 2 showed no sign of contaminant induced stress to wetland or terrestrial vegetation, although the BERA indicated that there may be a risk to terrestrial plants from exposure to lead in Area 2 floodplain surface soil;
- analyses of surface water samples indicate that unfiltered concentrations of metals are elevated at both Areas 2 and 3; however, these concentrations may be related to the high turbidity of the samples, and may not be bioavailable to ecological receptors. Therefore, there is uncertainty regarding the finding that aquatic organisms may be at risk from iron in surface water at 57D-95-05X (located adjacent to Area 2);
- while potential risks were also identified for benthic macroinvertebrates from exposure to metals, pesticides, PCBs, and PAHs in Areas 2 and 3 sediment based on conservative benchmark comparisons, this conclusion is not supported by the apparent lack of adverse effects in bulk sediment toxicity studies. Benthic macroinvertebrates may be at risk from copper and lead concentrations in sediment at sample location 57D-95-04X (concentrations of these analytes may be correlated with observed adverse growth responses for *C. tentans* in toxicity tests).

Based on a comparison of surface water data with upgradient groundwater data, Cold Spring Brook surface water in the vicinity of Area 2 may be impacted by groundwater discharge. However, there does not appear to be a risk to aquatic receptors from the chemicals common to both these media. Groundwater at Area 3 does not appear to be impacting downgradient surface water in the floodplain of Cold Spring Brook, based on the difference in chemicals detected in these media.

RECOMMENDATIONS

Based on the results and interpretations of the RI and the Human Health Risk Assessment, HLA recommends that a Feasibility Study be performed to evaluate alternatives to remove possible human health risks associated with potential future exposure to wetland soils by an excavation worker and hypothetical future residential exposures to soil and groundwater at AOC 57 Area 2.

A feasibility study is also recommended to evaluate alternatives to remove potential human health risks associated with potential future potable use of Area 3 groundwater and hypothetical future residential exposures to soil and groundwater.

No further action under CERCLA is recommended for Area 1 because unrestricted future land use does not pose any unacceptable risk.

1.0 INTRODUCTION

This Remedial Investigation (RI) Report (Data Item A009) for Area of Contamination (AOC) 57 was prepared by Harding Lawson Associates (HLA) as a component of Task Order 001 of Contract DACA31-94-D-0061 with the U.S. Army Corps of Engineers (USACE). This report details the results of the RI program at AOC 57, which was completed in accordance with relevant USACE, U.S. Army Environmental Center (USAEC), and U.S. Environmental Protection Agency (USEPA) guidance.

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, and was officially closed in September 1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens Reserve Forces Training Area (RFTA). Areas not retained as part of the Devens RFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment. AOC 57 is located in an area planned for transfer to the Massachusetts Government Land Bank for industrial/trade related development and recreation/open space.

1.1 PURPOSE AND SCOPE

The scope of work for the RI at AOC 57 was specified by the Army based on contaminants previously detected in groundwater and subsurface soil at AOC 57.

SITE CONDITIONS

AOC 57 consists of three subsites, Areas 1, 2, and 3, located to the southeast of Barnum Road on what was formerly the Main Post (Figure ES-1). A storm water drain that collects rainfall from the paved areas around Building 3713 has been designated as Area 1. Area 1 was investigated and addressed as part of the Area Requiring Environmental Evaluation (AREE) 70 (ADL, 1995), the Lower Cold Spring Brook Site Investigation (SI) (ABB-ES, 1995), the Lower Cold Spring Brook Site Investigation (SI) (ABB-ES, 1995), the Lower Cold Spring Brook SI (ABB-ES, 1995c), and the Study Area (SA) 57, Area 1 Contaminated Soil Removal (Weston, 1998). Area 2 previously consisted of an eroded drainage ditch created by periodic precipitation runoff from a vehicle storage yard; however, following a 1994 removal action the area was regraded and a stone drainage swale

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installed which discharges into Cold Spring Brook. During the removal action it was discovered that the soil and groundwater contamination were more widespread than expected. The soil removal was stopped and AOC 57 Area 2 was administratively transferred to the RI/FS process. Area 3 is located approximately 600 feet to the northeast of Area 2, south of former vehicle maintenance motor pools and north of the Cold Spring Brook floodplain. The site is characterized by a historic garage and vehicle waste disposal area. The focus of the RI was on Areas 2 and 3.

RI field work at AOC 57 proceeded in three phases, the initial RI field work in the Fall of 1995, the Modification field work in the Fall of 1996, and the Supplemental Investigation in the Spring of 1998.

The Fall 1995 field work focused primarily on Area 2; however, based upon historical photos which suggested soil staining, several test pits, Terraprobe points, and a monitoring well were installed in an area approximately 600 feet to northeast of Area 2. This location would be designated Area 3 and become the focus of the 1996 RI field investigation.

The following activities were included in the 1995 and 1996 field investigations:

- Background research of historical records, personnel interviews, areal photographic interpretation, and literature search was completed.
- A geophysical survey was completed at Areas 2 and 3 of the AOC to determine if any additional site-related contaminant source areas were present.
- Soil sampling with field analysis from test pits, soil borings, and TerraprobesTM were completed to define the horizontal and vertical distribution of soil contamination;
- Soil boring and test pit subsurface soil sampling for off-site laboratory analysis to confirm and supplement the field analysis;
- Installation of groundwater monitoring wells, piezometers, and the sampling of groundwater for off-site laboratory analyses;

- Surface water and sediment sampling for off-site laboratory analysis as well as biological and whole sediment sampling and analysis;
- Ecological survey and wetlands investigation;
- Aquifer testing;
- Vertical and horizontal location surveys.

The 1998 Supplemental RI field investigation was performed following the issuance of the AOC 57 Draft RI Report. The purpose of the 1998 investigation was to delineate the downgradient extent of contamination at Areas 2 and 3. Field activities consisted of:

- Collection and analyses of surface soils;
- Surface water and sediment sampling for off-site laboratory analysis;
- Installation and sampling of groundwater monitoring points.

As a result of the data obtained from the RI investigation, a contaminated soil removal was performed at AOC 57 Area 3. The removal action, focused on polychlorinated biphenyls (PCBs) and extractable petroleum hydrocarbons (EPH) in soil, was performed in three phases between March and June of 1999. A total of 1,860 cubic yards of soil were removed from Area 3. Confirmatory soil samples were collected from the excavation floor and walls to help direct the excavation.

1.2 REPORT ORGANIZATION

Preparation of this RI Report consisted of characterizing the geologic and hydrogeologic conditions and assessing the distribution, migration, potential receptors, and potential effects of identified chemicals on human and ecological receptors. The content and presentation of this report relies heavily upon figures and tables which present the data in the context of exploration locations on site maps. The text within the report supports the figures and tables, and provides detail, interpretation, and analysis that cannot be presented in figures and tables.

After acquiring and evaluating the field and off-site laboratory data and identifying chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs), HLA prepared this RI Report for AOC 57 in accordance with USEPA and Army guidance. The report describes the field methods employed, and presents, summarizes, and evaluates the relevant background information, field and laboratory data, results and conclusions from previous investigations, and assesses the potential human health and ecological risks.

Section 2.0 of this report describes the history and physical setting of the Devens area. Section 3.0 summarizes the RI analytical program, including the field procedures, off-site analytical procedures, QA and QC, and data management. Section 4.0 presents potential ARARs and background concentrations of inorganic analytes in soil and groundwater. Section 5.0 of this report summarizes the AOC 57 background and physical conditions, previous investigations, technical objectives of the RI, and RI sampling and investigatory techniques. Section 6.0 presents the interpretation of geologic and hydrogeologic conditions at AOC 57. Section 7.0 presents the results of previous investigations and the nature and distribution of site contaminants detected during the RI field investigations and 1999 Area 3 removal action. Section 8.0 outlines the fate and transport of the detected site contaminants. Section 9.0 presents the human health and ecological baseline risk assessment. Section 10.0 presents the conclusions and recommendations for AOC 57 Areas 1, 2, and 3. Figures and tables associated with each section are presented at the end of each section.

This RI Report will be presented as a Draft Final version, and after regulatory review, a Final version.

1.3 PROJECT OBJECTIVES

The objective of the project at AOC 57 was to perform an RI in accordance with relevant MADEP and USEPA guidance and in compliance with Army-approved field methods and procedures. The purpose of the RI conducted at AOC 57 was to further define the site contaminants detected in the soil and groundwater during previous site activities conducted at this AOC, and to determine whether remediation of the site contaminants is warranted.

1.4 PROJECT APPROACH

To meet the project objectives, a significant amount of effort was focused on the production of several RI planning documents. The planning documents were developed in compliance with the appropriate regulatory guidance for remedial investigations, regulatory and USAEC comments, and results of previous investigations.

The project plans were designed to answer data gaps identified from the previous investigations and gather additional data on the physical conditions of the AOC, the nature and distribution of site-related contaminants, and assess the risks to human and ecological receptors.

1.4.1 Project Operations Plan

The principal planning document was the HLA Fort Deven's Project Operations Plan (POP) (ABB-ES, 1995b), which provides detailed descriptions and discussions of the elements essential to conducting field investigation activities. The POP was revised before the 1995 RI field investigation to include new sampling techniques. The purpose of this plan was to define responsibilities and authorities for data quality, and to define requirements such that the field investigation activities undertaken by HLA at Devens would be planned and executed in a manner consistent with USAEC quality assurance (QA) program objectives. The POP includes the specified elements of a Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP). The SAP includes the essential elements of the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan. USEPA has prepared guidance on the preparation of a POP in "Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring"; (USEPA, 1984). The guidance was designed to eliminate the necessity for preparation of multiple, redundant documents.

The requirements of the POP were applied to HLA and subcontractor activities related to the collection of environmental data at Devens. The POP adheres to the requirements and guidelines contained in the "USAEC QA Program, January 1990" for collection and analysis of samples and the USAEC "Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports, March 1987" for the installation of borings and monitoring wells, and for land survey location. In addition, the POP meets guidelines of USAEC chain-of-custody (COC) procedures.

The HLA Devens POP provides guidance and specifications to ensure that samples are obtained under controlled conditions using appropriate, documented procedures; and that samples are identified uniquely and controlled through sample tracking systems and COC protocols. The POP also includes specifications to ensure that field determinations and laboratory analytical results are of known quality and are valid, consistent, and compatible with the USAEC chemical data base through the use of certified methods, preventive maintenance, calibration, and analytical protocols, quality control (QC) measurements, review, correction of out-of-control situations, and audits. The POP also specifies the methods and procedures to be used to ensure that calculations and evaluations are accurate, appropriate, and consistent throughout the projects; generated data are validated and their use in calculations is documented; and records are retained as documentary evidence of the quality of samples, applied processes, equipment, and results.

The HASP was prepared as an integral element of the POP in accordance with the same schedule and review requirements (ABB-ES, 1995b, Appendix A). The HASP complies with USAEC's EM 385-1-1, AMC-R-385-100, and Devens safety requirements, as well as Occupational Safety and Health Administration (OSHA) Regulations 29 CFR 1910.120. The HASP development was based on appropriate information contained in previous investigation documents from Devens. The HASP portion of the POP ensures that health and safety procedures are maintained by requiring inclusion of the health and safety staff function in the project organization.

1.4.2 Task Order Work Plans

The background, rationale, and specific scope for the RI are set forth in a second companion planning document, the Task Order Work Plan. The Revised Final Task Order Work Plan (ABB-ES, 1996a), Final Task Order Work Plan Addendum (ABB-ES, 1996b), and the Draft Supplemental Work Plan (HLA, 1998) for AOC 57 were prepared under Contract DAC31-94-D-0061 Task Order No. 001 and Modifications 001 and 004. The Work Plans were developed to comply with the Massachusetts Contingency Plan (MCP) (310 Code of Massachusetts Regulations [CMR] 40.000); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986; the corrective action provisions of the Hazardous and Solid Waste Amendments; and the Toxic Substances Control Act. Work conducted under the Work Plans was performed in accordance with the provisions of the FFA

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(USEPA and U.S. Army, 1991) and USAEC guidelines.

The background information provided in the Revised Final Task Order Work Plan, the Work Plan Addendum, and the Draft Supplemental Work Plan for AOC 57 was based largely on information in the Master Environmental Plan (MEP) (Biang et. al, 1992), review of installation documents, observations made during site visits conducted by HLA, interviews with installation personnel, and previous investigations. Summaries of each of these activities and discussions of specific field activities to be conducted under Task Order 001 and Modification 001 were included in the Revised Final Task Order Work Plan, the Work Plan Addendum, and the Draft Supplemental Work Plan. The discussions focused specifically on the objectives and scope of proposed RI activities.

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SECTION 2

2.0 INSTALLATION DESCRIPTION

Devens is located in the towns of Ayer and Shirley (Middlesex County) and Harvard and Lancaster (Worcester County), approximately 35 miles northwest of Boston, Massachusetts. It lies within the Ayer, Shirley, and Clinton map quadrangles (7¹/₂-minute series). The property occupies approximately 9,260 acres and was previously divided into the North Post, the Main Post, and the South Post (Figure 2-1).

Fort Devens was identified for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, and was officially closed in September 1996. Portions of the property formerly occupied by Fort Devens were retained by the Army for reserve forces training and renamed the Devens Reserve Forces Training Area (RFTA). Areas not retained as part of the Devens RFTA were, or are in the process of being, transferred to new owners for reuse and redevelopment. AOC 57 is located in an area planned for transfer to the Massachusetts Government Land Bank for industrial/trade related development and recreation/open space.

Over 6,000 acres at Fort Devens were used for training and military maneuvers, and over 3,000 acres were developed for housing, buildings, and other facilities; the installation has been reported as the largest undeveloped land holding under a single owner in north-central Massachusetts (United States Fish and Wildlife Service [USFWS], 1992).

The former South Post is located south of Massachusetts Route 2 and is largely undeveloped. The former Main Post and North Post primarily contain developed lands, including recreational areas, training areas, and an airfield. AOC 57 is located on the former Main Post (Figure 2-2).

The following subsections describe the history and physical setting of Devens.

2.1 HISTORY

Camp Devens was created as a temporary cantonment in 1917 for training soldiers from the New England area. It was named after Charles Devens -- a Massachusetts Brevet Major General in the Union Army during the Civil War who later became Attorney General under

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President Rutherford Hayes. Camp Devens served as a reception center for selectees, as a training facility, and, at the end of World War I, as a demobilization center (Marcoa Publishing Inc., 1990). At Camp Devens the 1918 outbreak of Spanish influenza infected 14,000 people, killed 800, and caused the installation to be quarantined (McMaster et al., 1982). Peak military strength during World War I was 38,000. After World War II, Camp Devens became an installation of the U.S. Army Field Forces, CONARC in 1962, and the U.S. Army Forces Command in 1973 (Biang et al., 1992).

In 1921, Camp Devens was placed in caretaker status. During summers from 1922 to 1931, it was used as a training camp for National Guard troops, Reserve units, Reserve Officer Training Corps cadets, and the Civilian Military Training Corps. In 1929, Dr. Robert Goddard used Fort Devens to test his early liquid-fuel rockets, and there is a monument to him on Sheridan Road near Jackson Gate (Fort Devens Dispatch, 1992).

In 1931, troops were again garrisoned at Camp Devens. It was declared a permanent installation, and in 1932 was formally dedicated as Fort Devens. During the 1930s, there was a limited building program, and beautification projects were conducted by the Works Progress Administration (WPA) and Civilian Conservation Corps.

In 1940, Fort Devens became a reception center for New England draftees. It expanded to more than 10,000 acres. Approximately 1,200 wooden buildings were constructed, and two 1,200-bed hospitals were built. In 1941, the Army Airfield was constructed by the WPA in a period of 113 days (Fort Devens Dispatch, 1992). In 1942, the Whittemore Service Command Base Shop for motor vehicle repair (Building 3713) was built, and at the time it was known as the largest garage in the world (U.S. Army, 1979). The installation's current wastewater treatment plant was also constructed in 1942 (Biang et al., 1992).

During World War II, more than 614,000 inductees were processed. Fort Devens' population reached a peak of 65,000. Three Army divisions and the Fourth Women's Army Corps trained at Fort Devens, and it was the location of the Army's Chaplain School, the Cook & Baker School, and a basic training center for Army nurses. A prisoner of war camp for 5,000 German and Italian soldiers was operated from 1944 to 1946. At the end of the war, Fort Devens again became a demobilization center, and in 1946 it reverted to caretaker status.

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Fort Devens was reactivated in July 1948 and again became a reception center during the Korean Conflict. Fort Devens served as an active army facility from that time until the Spring of 1996 when the Fort was officially closed.

2.2 PHYSICAL SETTING

The climate, vegetation, ecology, physiography, soils, surficial and bedrock geology, and regional hydrogeology of Devens are described in the subsections that follow.

2.2.1 Climate

The climate of Devens is typical of the northeastern United States, with long cold winters and short hot summers. Climatological data were reported for Devens by U.S. Department of the Army (1979), based in part on a 16-year record from Moore Army Airfield (MAAF).

The mean daily minimum temperature in the coldest months (January and February) is 17 degrees Fahrenheit (°F), and the mean daily maximum temperature in the hottest month (July) is 83°F. The average annual temperature is 58°F. There are normally 12 days per year when the temperature reaches or exceeds 90°F and 134 days when it falls to or below freezing.

The average annual rainfall is 39 inches. Mean monthly precipitation varies from a low of 2.3 inches (in June) to a high of 5.5 inches (in September). The average annual snowfall is 65 inches, and snowfall has been recorded in the months of September through May (falling most heavily from December through March).

Wind speed averages 5 miles per hour (mph), ranging from the highest monthly average of 7 mph (March-April) to the lowest monthly average of 4 mph (September).

Average daytime relative humidities range from 71 percent (January) to 91 percent (August), and average nighttime relative humidities range from 46 percent (April) to 60 percent (January).

SECTION 2

2.2.2 Vegetation

The former Main and North Posts at Devens are primarily characterized by urban and developed cover types. Approximately 56 percent of these areas are covered by developed lands. Early successional forest cover types (primarily black cherry-aspen hardwoods) cover approximately 2 percent of the area, mixed oak-red maple hardwoods approximately 20 percent, and white pine-hardwood mixes approximately 11 percent. The rest of the former North and Main Posts are characterized by various coniferous species, shrub habitat, and herbaceous cover types.

Much of the former South Post is undeveloped forested land. The area includes approximately 8 percent early successional forest (black cherry, red birch, grey birch, quaking aspen, red maple); 26 percent mixed oak hardwoods; and 9 percent coniferous forest (white pine, pitch pine, red pine). Four percent of the area comprises a mixed shrub community. The 200-acre Turner Drop Zone is maintained as a grassland that represents a "prairie" habitat. Vegetative cover in the large "impact area" of the central South Post has not been mapped in detail. It is dominated by fire-tolerant species such as pitch pine and scrub oak.

Extensive sandy glaciofluvial soils are found in the Nashua River Valley, particularly in the former South and North Post areas of Devens. Extensive accumulations of these soils are unusual in Massachusetts outside of Cape Cod and adjacent areas of southeastern Massachusetts, and they account for some of the floral and faunal diversity at the installation.

2.2.3 Ecology

Devens encompasses numerous terrestrial, wetland, and aquatic habitats in various successional stages. Floral and faunal diversity is strengthened by the installation's close proximity to the Nashua River; the amount, distribution, and nature of wetlands; and the undeveloped state and size of the South Post (USFWS, 1992). Much of Devens was formerly agricultural land and included pastures, woodlots, orchards, and cropped fields. Existing habitat types reflect this agrarian history, ranging from abandoned agricultural land to secondary growth forested regions. Devens is generally reverting back to a forested state.

There are 1,313 acres of wetlands at Devens. The wetlands are primarily palustrine, although riverine and lacustrine types are also found. Forested palustrine floodplain wetlands associated with the Nashua River and its tributary Nonacoicus Brook are located on Devens' Main and North Posts. These include 191 acres of flooded areas, emergent marsh, and shrub wetlands. Also present are 245 acres of isolated regions of palustrine wetlands and lacustrine systems. On the South Post, there are 877 acres of wetlands, consisting of deciduous forested wetlands, deciduous shrub swamps, emergent marsh, open lacustrine waters in ponds, and open riverine waters.

Approximately half of Devens' land area abuts the northern boundary of the Oxbow National Wildlife Refuge (NWR), a federal resource administered as part of the Great Meadows NWR (USFWS, 1992).

Devens supports an abundance and diversity of wildlife. Identified taxa include 771 vascular plant species, 538 species of butterflies and moths, eight tiger beetle species, 30 vernal pool invertebrates, 15 amphibian species (six salamanders, two toads, seven frogs), 19 reptile species (seven turtles, 12 snakes), 152 bird species, and 42 mammal species. The status of fish populations in Devens aquatic systems has not been fully defined.

Rare and endangered species at Devens include the federally listed (endangered) bald eagle and peregrine falcon (both occasional transients); the state-listed (endangered) upland sandpiper, ovoid spike rush, and Houghton's flatsedge; the state-listed (threatened) Blanding's turtle, cattail sedge, pied-billed grebe, and northern harrier; and the state-listed (special concern) blue-spotted salamander, grasshopper sparrow, spotted turtle, wood turtle, water shrew, blackpoll warbler, American bittern, Cooper's hawk, sharp-shinned hawk, and Mystic Valley amphipod. Also state-listed as rare or endangered are three Lepidoptera (butterfly and moth) species identified at Devens.

The Massachusetts Natural Heritage Program has developed Watch Lists of unprotected species that are uncommon or rare in Massachusetts. From the Watch Lists, 14 plant species, two amphibian species, and 15 bird species have been observed at Devens.

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2.2.4 Physiography

Devens is in a transitional area between the coastal lowland and central upland regions of Massachusetts. All of the landforms are products of glacial erosion and deposition on a crystalline bedrock terrain. Glacial erosion was superimposed on ancient bedrock landforms that were developed by the erosional action of preglacial streams. Generally, what were bedrock hills and ridges before the onset of Pleistocene glaciation were only moderately modified by glacial action, and they remain bedrock hills and ridges today. Similarly, preglacial bedrock valleys are still bedrock valleys. In post-glacial time, streams have locally modified the surficial glacial landforms but generally have not affected bedrock.

The predominant physiographic (and hydrologic) feature in the Devens area is the Nashua River (see Figure 2-1). It forms the eastern installation boundary on the South Post, where its valley varies from a relatively narrow channel (at Still River Gate), to an extensive floodplain with a meandering river course and numerous cutoff meanders (at Oxbow National Wildlife Sanctuary). The Nashua River forms the western boundary of much of the Main Post, and there its valley is deep and comparatively steep-sided with extensive bedrock outcroppings on the eastern bank. The river flows through the North Post in a well-defined channel within a broad forested floodplain.

Terrain at Devens falls generally into three types. The least common is bedrock terrain, where rocks that have been resistant to both glacial and fluvial erosion remain as topographic highs, sometimes thinly veneered by glacial deposits. Shepley's Hill on the former Main Post is the most prominent example.

A similar but more common terrain at Devens consists of materials (tills) deposited directly by glaciers as they advanced through the area or as the ice masses wasted (melted). These landforms often conform to the shape of the underlying bedrock surface. They range from areas of comparatively low topographic relief (such as near Lake George Street on the former Main Post) to elongated hills (drumlins) whose orientations reflect the direction of glacier movement (such as Whittemore Hill on the former South Post).

The third type of terrain was formed by sediment accumulations in glacial-meltwater streams and lakes (glaciofluvial and glaciolacustrine deposits). This is the most common terrain at Devens. Its form bears little or no relationship to the shape of the underlying

bedrock surface. Landforms include extensive flat uplands such as the hills on which the air field and the wastewater infiltration beds are located on the former North Post. Those are large remnants of what was once a continuous surface that was later incised and divided by downcutting of the Nashua River. Another prominent glacial meltwater feature is the area around Cranberry Pond and H-Range on the former South Post. This is classic kame-and-kettle topography formed by sand and gravel deposition against and over large isolated ice blocks, followed by melting of the ice and collapse of the sediments. The consistent elevations of the tops of these ice-contact deposits are an indication of the glacial-lake stage with which they are associated. Mirror Lake and Little Mirror Lake on the former Main Post occupy another conspicuous kettle.

2.2.5 Soils

Devens lies within Worcester County and Middlesex County in Massachusetts (see Figure 2-1). The soils of Worcester County have been mapped by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture (USDA) (SCS, 1985). Mapping of the soils of Middlesex County has not been completed. However, an interim report (SCS, 1991), field sheet #19 (SCS, 1989), and an unpublished general soil map (SCS, undated) are available.

Soil mapping units ("soil series") that occur together in intricate characteristic patterns in given geographic areas are grouped into soil "associations." Soils in the Worcester County portions of Devens consist generally of three associations. Three associations also have been mapped in the Middlesex County portions of Devens. Although the mapped associations are not entirely the same on both sides of the county line, the differences reflect differences in definition and the interim status of Middlesex County mapping. The general distributions of the soil associations are shown in Figure 2-3, and descriptions of the soil series in those associations are provided below.

WORCESTER COUNTY (SCS, 1985)

Winooski-Limerick-Saco Association:

<u>Winooski Series</u>. Very deep; moderately well-drained; slopes 0 to 3 percent; occurs on floodplains; forms in silty alluvium.

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<u>Limerick Series</u>. Very deep; poorly drained; slopes 0 to 3 percent; occurs on floodplains; forms in silty alluvium.

<u>Saco Series</u>. Very deep; very poorly drained; slopes 0 to 3 percent; occurs on floodplains; derived mainly from schist and gneiss.

Hinckley-Merrimac-Windsor Association:

<u>Hinckley Series</u>. Very deep; excessively drained; slopes 0 to 35 percent; occurs on stream terraces, eskers, kames, and outwash plains.

<u>Merrimac Series</u>. Very deep; excessively drained; slopes 0 to 25 percent; occurs on stream terraces, eskers, kames, and outwash plains.

<u>Windsor Series</u>. Very deep; moderately well-drained; slopes 0 to 3 percent; occurs on floodplains.

Paxton-Woodbridge-Canton Association:

<u>Paxton Series</u>. Very deep; well-drained; slopes 3 to 35 percent; occurs on glacial till uplands; formed in friable till overlying firm till.

<u>Woodbridge Series</u>. Very deep; moderately well-drained; slopes 0 to 15 percent; occurs on glacial till uplands; formed in firm till.

<u>Canton Series</u>. Very deep; well-drained; slopes 3 to 35 percent; occurs on glaciated uplands; formed in friable till derived mainly from gneiss and schist.

MIDDLESEX COUNTY (SCS, 1991)

<u>Hinckley-Freetown-Windsor Association</u>: The soils at AOC 57 are comprised of this soil type (See Figure 2-3). (This is a continuation of the Hinckley-Merrimac-Windsor Association mapped in Worcester County):

<u>Hinckley Series</u>. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash terraces, kames, and eskers; formed in gravelly and cobbley coarse

textured glacial outwash.

<u>Freetown Series</u>. Deep; very poorly drained; nearly level, organic; occurs in depressions and on flat areas of uplands and glacial outwash plains.

Windsor Series. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash plains, terraces, deltas, and escarpments; formed in sandy glacial outwash.

Quonset-Carver Association:

<u>Quonset Series</u>. Deep; excessively drained; nearly level to very steep; occurs on glacial outwash plains, terraces, eskers, and kames; formed in water-sorted sands derived principally from dark phyllite, shale, or slate.

<u>Carver Series</u>. Deep; excessively drained; nearly level to steep; occurs on glacial outwash plains, terraces, and deltas; formed in coarse, sandy, water-sorted material.

<u>Winooski-Limerick-Saco Association</u>: (This is a continuation of the same association mapped along the Nashua River floodplain in Worcester County).

2.2.6 Surficial Geology

Devens lies in three topographic quadrangles: Ayer, Clinton, and Shirley. The surficial geology of Devens has been mapped only in the Ayer quadrangle (Jahns, 1953) and Clinton quadrangle (Koteff, 1966); the Shirley quadrangle is unmapped.

Unconsolidated surficial deposits of glacial and postglacial origin comprise nearly all of the exposed geologic materials at Devens. The glacial units consist of till, deltaic deposits of glacial Lake Nashua, and deposits of glacial meltwater streams.

The surficial geology at AOC 57 can be placed in the following geologic setting. The till ranges from unstratified gravel to silt, and it is characteristically bouldery. Jahns (1953) and Koteff (1966) recognize a deeper unit of dense, subglacial till, and an upper, looser material that is probably a slightly younger till of englacial or superglacial origin. Till is exposed in ground-moraine areas of the former Main Post (such as in the area of Lake George Street)

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and on the former South Post at and south of Whittemore Hill. It also underlies some of the water-laid deposits (Jahns, 1953). Till averages approximately 10 feet in thickness but reaches 60 feet in drumlin areas (Koteff, 1966).

Most of the surficial glacial units in the Nashua Valley are associated with deposition in glacial Lake Nashua, which formed against the terminus of the Wisconsinian ice sheet as it retreated northward along the valley. Successively lower outlets were uncovered by the retreating glacier, and the lake level was correspondingly lowered. Koteff (1966) and Jahns (1953) recognize six lake levels (stages) in the Devens area, distinguished generally by the elevations and distribution of their associated deposits. The stages are, in order of development: Clinton Stage; Pin Hill Stage; Old Mill Stage; Harvard Stage; Ayer Stage; and Groton Stage.

The glacial lake deposits consist chiefly of sand and gravelly sand. Coarser materials are found in topset beds of deltas built out into the lakes and in glacial stream beds graded to the lakes. Delta forest beds are typically composed of medium to fine sand, silt, and clay. Lake-bottom deposits, which consist of fine sand, silt, and clay, are mostly covered by delta deposits and are seldom observed in glacial Lake Nashua deposits. One of the few known exposures of glacial lake-bottom sediments in the region is on the former South Post near A- and C-Ranges. There, a section of more than 14 feet of laminated clay was mined for brick-making in the early part of this century (Alden, 1925, pp. 70-71). The general physical characteristics of glacial lake deposits are the same regardless of the particular lake stage in which the deposits accumulated (Koteff, 1966; Jahns, 1953). Although glaciofluvial and glaciolacustrine sediments are typically abrupt changes characteristic of these generally high-energy depositional environments.

Postglacial deposits consist mostly of river-terrace sands and gravels; fine alluvial sands and silts beneath modern floodplains; and muck, peat, silt, and sand in swampy areas.

Jahns (1953) also observed a widespread veneer of windblown sand and ventifacts above the glacial materials (and probably derived from them in the brief interval between lake drainage and the establishment of vegetative cover).

2.2.7 Bedrock Geology

Devens is underlain by low-grade metasedimentary rocks, gneisses, and granites. The rocks range in age from Late Ordovician to Early Devonian (approximately 450 million to 370 million years old). The installation is situated approximately 2 miles west of the Clinton-Newbury-Bloody Bluff fault zone, that developed when the ancestral European continental plate collided with and underthrust the ancestral North American plate. The continents reseparated in the Mesozoic to form the modern Atlantic Ocean. Devens is located on the very eastern edge of the ancestral North American continental plate. A piece of the ancestral European continent (areas now east of the Bloody Bluff fault) broke off and remained attached to North America.

Preliminary bedrock maps (at scale 2,000 feet/inch) are available for the Clinton quadrangle (Peck, 1975 and 1976) and Shirley quadrangle (Russell and Allmendinger, 1975; Robinson, 1978). Bedrock information for the Ayer quadrangle is from the Massachusetts state bedrock map (at a regional scale of 4 miles/inch) (Zen, 1983) and in associated references (Robinson and Goldsmith, 1991; Wones and Goldsmith, 1991). Among these sources, there is some disagreement about unit names and stratigraphic sequence; however, there is general agreement about the distribution of rock types.

In contrast to the high metamorphic grade and highly sheared rocks of the Clinton-Newbury zone, the rocks in the Devens area are low grade metamorphics (generally below the biotite isograd) and typically exhibit less brittle deformation. Major faults have been mapped, however, including the Wekepeke Fault exposed west of Devens (in an outcrop 0.25 mile west of the old Howard Johnson rest stop on Route 2).

Figure 2-4 is a generalized summary of the bedrock geology of Devens. It is compiled from Peck (1975), Robinson (1978), Russell and Allmendinger (1975), and Zen (1983), and it adopts the nomenclature of Zen (1983). Because of limited bedrock exposures, the locations of mapped contacts are considered approximate, and the mapped faults are inferred. Rock units strike generally northward to northeastward but vary locally. The bedrock units underlying Devens are as follows:

DSw WORCESTER FORMATION (Lower Devonian and Silurian) Carbonaceous slate and phyllite, with minor metagraywacke to the west (Zen, 1983; Peck, 1975). Bedding is typically obscure due to a lack of compositional differences. It is

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relatively resistant to erosion and forms locally prominent outcrops. The abandoned Shaker slate quarry on the South Post is in rocks of the Worcester Formation. The unit corresponds to the "DSgs" and "DSs" units of Peck (1975) and the "e3" unit of Russell and Allmendinger (1975).

- So OAKDALE FORMATION (Silurian) Metasiltstone and phyllite. It is finegrained and consists of quartz and minor feldspar and ankerite, and it is commonly deformed by kink banding (Zen, 1983; Peck, 1975; Russell and Allmendinger, 1975). In outcrop it has alternating layers of brown siltstone and greenish phyllite. The Oakdale Formation crops out most visibly on Route 2 just east of the Jackson Gate exit. It corresponds to the "DSsp" unit of Peck (1975), the "e2" unit of Russell and Allmendinger (1975), and "ms" unit of Robinson (1978).
- Sb **BERWICK FORMATION** (Silurian) Thin- to thick-bedded metamorphosed calcareous metasiltstone, biotitic metasiltstone, and fine-grained metasandstone, interbedded with quartz-muscovite-garnet schist and feldspathic quartzite (Zen, 1983; Robinson and Goldsmith, 1991). In areas northwest of Devens, cataclastic zones have been observed (Robinson, 1978). The bedrock below AOC 57 belongs to this formation.
- Dcgr CHELMSFORD GRANITE (Lower Devonian) Light-colored and gneissic, even and medium-grained, quartz-microcline-plagioclase-muscovite-biotite, pervasive ductile deformation visible in elongate quartz grains aligned parallel to mica. It intrudes the Berwick Formation and Ayer granite (Wones and Goldsmith, 1991).

AYER GRANITE

- Sacgr Clinton facies (Lower Silurian) Coarse-grained, porphyritic, foliated biotite granite with a nonporphyritic border phase; it intrudes the Oakdale and Berwick Formations and possibly the Devens-Long Pond Facies (Zen, 1983; Wones and Goldsmith, 1991).
- SOad **Devens-Long Pond facies** (Upper Ordovician and Lower Silurian) Gneissic, equigranular to porphyoblastic biotite granite and granodiorite. Its contact relationship with the Clinton facies is unknown (Wones and Goldsmith, 1991). Observations of mapped exposures of this unit at Devens

indicate that it may not be intrusive.

Bedrock is typically unweathered to only slightly weathered at Devens. Glaciers stripped away virtually all of the preglacially weathered materials, and there has been insufficient time for chemical weathering of rocks in the comparatively brief geologic interval since glacial retreat.

2.2.8 Regional Hydrogeology

Devens is in the Nashua River drainage basin, and the Nashua River is the eventual discharge locus for all surface water and groundwater flow at the installation.

The water of the Nashua River has been assigned to Class B under Commonwealth of Massachusetts regulations. Class B surface water is "designated for the uses of protection and propagation of fish, other aquatic life and wildlife, and for primary and secondary contact recreation" (314 CMR 4.03).

The principal tributaries of the north-flowing Nashua River at Devens are Nonacoicus Brook and Walker Brook on the former North Post; Cold Spring Brook (which is a tributary of Nonacoicus Brook) on the former Main Post; and Spectacle Brook and Ponakin Brook (tributaries of the North Nashua River), Slate Rock Brook, and New Cranberry Pond Brook on the former South Post. Cold Spring Brook is located at the southern boundary of AOC 57 (see Figure 2-5).

There are two ponds on Devens' South Post that are called Cranberry Pond. The isolated kettle pond located east of H-Range is referred to as Cranberry Pond, and the pond impounded in the 1970s 0.5-mile west of the Still River gate is referred to as New Cranberry Pond.

Glacial meltwater deposits constitute the primary aquifer at Devens. In aquifer tests performed as part of previous investigations, measured hydraulic conductivities in meltwater deposits were comparatively high - typically 10^{-3} to 10^{-2} centimeters per second (cm/sec). In till and in clayey lake-bottom sediments, measured hydraulic conductivities were lower and ranged generally from 10^{-6} to 10^{-4} cm/sec. Groundwater also occurs in the underlying bedrock; however, flow is limited because the rocks have no primary porosity and water moves only in fractures and dissolution voids.

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Groundwater in the surficial aquifer at Devens has been assigned to Class I under Commonwealth of Massachusetts regulations. Class I consists of groundwaters that are "found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock and are designated as a source of potable water supply" (314 CMR 6.03).

The transmissivity of an aquifer is the product of its hydraulic conductivity and saturated thickness, and as such it is a good measure of groundwater availability. Figure 2-5 shows aquifer transmissivities at Devens, based on the regional work of Brackley and Hansen (1977). Transmissivities in the meltwater deposits range from 10 square feet per day (ft²/day) to more than 4,000 ft²/day. Aquifer transmissivities between 10 and 1,350 ft²/day correspond to potential well yields generally between 10 and 100 gallons per minute (gpm); transmissivities from 1,350 to 4,000 ft²/day typically yield from 100 to 300 gpm; and where transmissivities exceed 4,000 ft²/day, well yields greater than 300 gpm can be expected. (Most domestic wells in the area are drilled 100 to 200 feet into bedrock and yield less than 10 gpm. Higher yields are associated with deeper bedrock wells.)

In Figure 2-5, the zones of highest transmissivity are found in areas of thick glacial meltwater deposits on the former North and Main Posts, and these encompass the Sheboken, Patton, and McPherson production wells and the largely inactive Grove Pond well-field. AOC 57 is located between Patton production well and the Grove Pond wells. Groundwater from AOC 57 does not appear to flow toward either well as it discharged to Cold Spring Brook (see Figure 2-5). The zones of lowest transmissivity are associated with exposed till and bedrock and are located on the former Main Post surrounding Shepley's Hill and between Jackson Gate and the parade ground, and on the former South Post at Whittemore Hill and isolated areas to the north and west.

A regional study of water resources in the Nashua River basin was reported by Brackley and Hansen (1977). A digital model of groundwater flow at Devens is available in a report by Engineering Technologies Associates, Inc. (ETA) (1995).

According to ETA (1995), in the absence of pumping or other disturbances, groundwater recharge occurs in upland areas (e.g., the high ground on the Main Post between Queenstown, Givry, and Lake George Streets, and on the South Post the area around Whittemore Hill). The groundwater flows generally from the topographic highs to topographic lows. It discharges in wetlands, ponds, streams, and directly into the Nashua

River. Groundwater discharge maintains the dry-weather flow of the rivers and streams. Figures 2-6 and 2-7, respectively, present ETA's regional overburden and bedrock groundwater flow maps (ETA, 1995).

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3.0 ANALYTICAL PROGRAM

Based on data obtained from previous investigations summarized in the Final Task Order Work Plan for AOC 57, 63AX, and 69W (ABB-ES, 1996), an analytical program for the RI was established to identify contaminants that were potentially present at AOC 57 due to historical activities. Fuel hydrocarbons and chlorinated solvent contaminants were discovered in past investigations at AOC 57. The purpose of the following subsection is to outline only those analytical procedures used during the RI program. Analytical results generated during previous activities including Site Investigations, AREE 70, and Soil Removal Action will be included in the RI; however, the analytical programs are not described in this document. Previously published documents containing information on analytical programs from historical activities are referenced in Section 7.0.

The AOC 57 RI analytical program included field analysis as well as off-site laboratory analyses for a predetermined set of organic and inorganic analytes. The specific analyses implemented for these investigations are outlined in Subsection 3.1 for the on-site methods and Subsection 3.2 for the off-site analytical program. Samples were collected during RI field investigations completed in 1995 and 1996, the 1998 Supplemental field investigation, and Area 3 source area soil removal completed in 1999. The following subsections describe the field and off-site analytical programs implemented for the RI completed by HLA at AOC 57 Areas 2 and 3.

3.1 FIELD ANALYTICAL METHODS

Samples were analyzed in the field during the RI investigation to provide real-time chemical data. Soil and groundwater samples were analyzed for selected volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPHC). Data were primarily used to evaluate the distribution of benzene, toluene, ethylbenzene, and xylene (BTEX), chlorinated solvents, and TPHC contamination in groundwater and soil at AOC 57. A discussion of field analytical procedures, data quality objectives, field documentation procedures, and quality control steps are outlined in Subsection 4.6 of the POP (ABB-ES, 1995b). Target compounds and detection limits for on-site field analysis compounds are outlined in Table 3-1.

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TPHC analyses using a Miran Fixed Filter Infrared Spectrophotometer (IR) was the primary field method for evaluating semivolatile petroleum hydrocarbons in soil samples. This method is similar to USEPA Method 418.1. A soil microextraction sample preparation technique was developed for use in a field laboratory. This method provides qualitative data on the presence and absence, and relative concentration, of hydrocarbons. Diesel Range Organics (DRO) gas chromatography (GC)/Flame Ionization Detector (FID) analysis was also conducted on a subset of soils to provide semiquantitative data on medium molecular weight range petroleum hydrocarbons. DRO analysis was conducted for a subset of samples that exhibited hydrocarbon characteristics on the VOC analysis.

A Hewlett Packard 5890 Series II GC, in series with a Tekmar 3000 purge and trap concentrator, was used to measure concentrations of VOCs in the different matrices. Target analytes included BTEX, chlorinated solvents, and gasoline range organics (GRO) to measure the volatile petroleum reaction of hydrocarbons. Several detectors were used in conjunction with the GC during the field programs. Detectors included a FID, photoionization detector (PID), and electron capture detector (ECD).

3.1.1 Instrument Calibration

For analysis of samples for target compounds using a GC, an initial calibration was established. The initial calibration was accomplished through the analysis of three to five different concentrations of working standards. The response of the instrument to each standard was plotted versus the concentrations of standards to establish a calibration curve. The range of standards used to create the calibration curve was determined by the anticipated range of VOC contamination. Once all points were established on the calibration curve, the linearity was measured using linear regression analysis. The r² value, which provided a measure of this linearity, was required to be a minimum of 0.95 for all target analytes.

Prior to analysis of samples, a continuing calibration check standard was analyzed each day to ensure that the response of the instrument had not changed from the initial calibration. The concentration of the check standard was at mid-level in the calibration curve. The initial calibration remained valid if concentrations obtained for the target analytes were no greater than 30 percent different from values obtained from the initial calibration. If greater than two target compounds for multianalyte analysis for BTEX and chlorinated compounds were outside the 30 percent difference, a new initial calibration was created.

3.1.2 Sample Preparation and Analysis

Sample preparation for the total petroleum hydrocarbon procedure (IR analysis) is detailed in Subsection 4.6.2 of the Fort Devens POP (ABB-ES, 1995b). The IR analysis was used for gross hydrocarbon measurements and to indicate the presence or absence of contamination. A freon-113 extraction similar to that described above for DRO was used to prepare samples. Samples were analyzed by USEPA Method 418.1 (USEPA, 1983).

Sample preparation techniques for GC VOCs and GRO were adapted from protocols outlined in USEPA Method 8010 and 8015 (USEPA, 1986). Soil samples were prepared for field analysis by the measurement of 5 grams into a soil sparger. For water samples, the amount used was 5 milliliters (mL). Both soil and groundwater samples were loaded onto the purge and trap concentrator. Helium was purged through the sample to carry compounds onto a cold, compound-capturing silica/charcoal trap. The trap was heated to 235 degrees Celsius (°C) to liberate volatile compounds into a DB-624 capillary column which was installed in the gas chromatograph. The capillary column served the purpose of separating out the various compounds. The amount of time spent in the capillary column (retention time) by each compound was influenced by its molecular weight and the temperature program of the GC. A retention time window of +/- 3 percent was used for the identification of target compounds.

For DRO analysis sample preparation, techniques were adapted from USEPA Method 3550 and Method 8015 (USEPA, 1986). The extraction procedure required the measurement of 2 grams of soil into a test tube with the addition of 2 grams of sodium sulfate and 2 mL of methylene chloride (solvent). The supernatant was then transferred to an injection vial labeled with the sample identification. The GC, equipped with an autosampler for a 2 microliters (μ L) sample volume injection, then analyzed the sample for identification and quantitation of DRO concentration. Additional solvent may have been added if a sufficient volume of supernatant was not initially achieved. If additional solvent was added, a dilution factor was incorporated during sample quantitation.

3.1.3 Target Compound Concentrations Calculations

Target VOC concentrations were determined from comparisons of responses of compounds in samples versus responses from standards in the initial calibration curves described in

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Subsection 3.1.1. Soil compound concentrations were reported on a dry weight basis. Solid fraction data was used to calculate final VOC, GRO, DRO, and IR concentrations. Dilutions performed on both water and soil samples also were used to calculate final VOC, GRO, DRO, and IR concentrations. Dilution factors were calculated for any analyses where sample amounts were modified due to high concentrations of chemicals present in samples. Final sample results were calculated by dividing original unadjusted sample results by fraction of solid and multiplying results by any dilution factors.

Based on secondary data reviews conducted by the HLA Quality Assurance Officer and project chemist, possible data bias was identified in the GRO and DRO data set. The possible data bias is discussed below for GRO and DRO.

The results of the GRO analyses contain a possible positive bias which over-estimated the measured concentration by approximately 20 percent of the true value. The bias was introduced during the preparation of the stock standard for the GRO analysis. The density of GRO was approximated as the density of benzene (0.88 grams per milliliter [g/mL]), however, according to information in the Installation Restoration Program Toxicology Guide (U.S. Air Force) gasoline has a density of approximately 0.73 g/mL.

The results of the DRO analyses should be considered estimated. Possible impacts on quantitation of hydrocarbons was introduced during the set-up of the GC analytical run program. The instrument conditions used for DRO analyses caused the loss of approximately 25 percent of the light end hydrocarbons within the diesel hydrocarbon range. The primary purpose of the DRO analysis was to estimate concentrations of fuel oils or waste oils at the site. The analytical run would effectively detect the medium to heavy molecular weight fraction of oil products; however, concentrations should be considered estimated within approximately 0.5 to 2 times the reported concentration.

3.1.4 Field Documentation Procedures

Instrument logbooks were completed for each instrument used during each of the field analytical programs. A log of all chromatography runs was recorded in these logbooks. The logbooks recorded the concentrations for all calibration standards used, sample run number, sample identification, date, standard preparation records, instrument maintenance records, percent solid determination data, sample volume or weight, and any additional comments or observations of the field chemist. In addition, the results from each GC run

were saved into a computerized database.

At the conclusion of the RI field efforts, raw data from the GC analyses and instrument logbooks were transferred for storage at HLA's Portland, Maine office. Raw data includes chromatograms, quantitation reports, and instrument and notebook records to document analyses.

3.1.5 Field Analytical Quality Control

A QC program for the field analytical results was established prior to commencement of the RI on-site laboratory analysis. This program was developed to ensure that the data generated at the field laboratory was of sufficient quality to be considered satisfactory for its intended use. QC parameters for the RI field analytical program included initial and daily calibration check standard runs, mid-level calibration check standards after every ten samples, low-level and mid-level method blanks, cleaning blanks, and field or laboratory duplicates. QC objectives for the on-site laboratory analyses are outlined in the Fort Devens POP (ABB-ES, 1995b) and Appendix D of this report. QC sample results for the on-site laboratory are assessed in Appendix D.

Method blanks were analyzed daily to document that the analytical system was free of contamination. Samples were not run if the there were any target compounds detected above the Practical Quantitation Limit (PQL) in the method blank. In addition to the low-level method blank, a mid-level method blank was run in instances where methanol extractions were necessary. One hundred μ L of methanol were added to deionized water and analyzed to ensure that it was free of contamination.

During VOC GC analyses, cleaning blanks were run at the beginning of each day to show that the analytical system was clean. They were also run after particularly heavily contaminated samples were run through the GC.

For VOC analyses, a surrogate was added to every sample to determine if the matrix was having an effect on the recovery of the target compounds. The surrogate used for all field investigations was 4-Bromofluorobenzene. This surrogate was used because it is chemically similar to the target compounds and responds well on the detectors selected for the field programs. Surrogate recoveries had to be from 30 percent to 170 percent to be considered acceptable. Samples for which the surrogate did not meet this criteria were

reanalyzed and/or qualified.

Field duplicate samples were also analyzed to determine the precision of sampling and analytical techniques. Reported concentrations of target compounds for each sample and associated duplicate pair were compared by calculating the relative percent difference (RPD) of the results. RPDs were compared to criteria from USEPA (hazardous site evaluation division) Region I laboratory data validation functional guidelines for evaluating organics analyses to evaluate the precision of measurements. Duplicate results for the RI are presented in Appendix D.

In some instances, data qualifiers were used to address data quality issues associated with a particular sample. The following qualifiers were used during the RI at Fort Devens:

- J Denotes target compound concentrations that are estimated.
- E Denotes target compound concentrations that exceed the highest standard of the calibration curve.
- U Denotes sample concentrations that are less than PQLs.
- N Denotes a value that is a possible false positive due to method blank contamination.

Results of the on-site sample analyses are presented in discussions of the nature and distribution of site contaminants, in Section 7.0 and Appendix M of this report.

3.1.6 Method Detection Limits and Data Qualifiers

Method Detection Limits (MDLs) were established during the RI for the electronic conductivity detector (ELCD), PID, and the FID detector target compounds. The MDL study was completed for all VOC target compounds to provide data to support the PQLs established for the various field programs. MDLs were calculated based on procedures published in CFR Appendix B, Part 136, vol. 49, no. 209. The MDL study provides an estimation of the lower concentration limit of what the detectors were able to measure. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. For each compound, this was determined by running seven consecutive runs of a premixed

standard at a concentration believed to be near the threshold of detection. The concentration for all target compounds in the MDL study was 2 micrograms per liter (μ g/L). 1,1-Dichloroethane was not observed at this concentration with reliability, and the MDL was not determined. The 1,1-dichloroethane PQL was set at 5 μ g/L. The MDLs obtained during the RI field analytical program are presented in Table 3-1.

The PQL was established to provide a margin of error from the MDL, since the MDL identifies the threshold concentration of what the detector was capable of measuring. PQLs for the RI program are outlined on Table 3-1.

3.2 OFF-SITE LABORATORY ANALYTICAL PARAMETERS

Soil and groundwater samples collected during the RI from AOC 57 were analyzed at an off-site laboratory for chemical parameters on the Fort Devens/Devens Project Analyte List (PAL). Off-site laboratory analyses for PAL organics and inorganics are considered definitive data (USEPA, 1993). The Fort Devens/Devens PAL and off-site laboratory methods are described in the Fort Devens POP (ABB-ES, 1995b) and Appendix D of this report.

Off-site laboratories performing the analytical work for Fort Devens/Devens during remedial investigations completed before 1999 were required to implement the 1990 U.S. Army Toxic and Hazardous Materials Agency (USATHAMA, now USAEC) QA Program (USATHAMA, 1990). Method performance demonstrations, data management, and oversight for previous USATHAMA analytical procedures were performed by the USAEC. The off-site laboratory contracted to implement the analytical program for the RI at AOC 57 was Environmental Science and Engineering, Inc. (ESE) of Gainesville, Florida (later QST Environmental). This laboratory completed analyses using USATHAMA and USEPA methods. Analyses were completed while implementing the 1990 USATHAMA QA Program. Specific performance demonstration and QC components of the 1990 USATHAMA QA Plan are detailed in Subsection 3.2.3 of this report.

Samples collected during the Source Area 3 removal action included hydrocarbon analyses using Massachusetts volatile petroleum hydrocarbon (VPH) and EPH methods (MADEP, 1998), and pesticide and PCB analyses using USEPA SW846 methods (USEPA, 1996). Samples were analyzed by a USACE certified laboratory. A data

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quality review was performed by the HLA project chemist. A data quality review is provided in Appendix D5, and results are reported in Section 7.0. Results from the Source Area 3 removal action are not reported on the USAEC IRDMIS.

The following subsection describes the procedures implemented to achieve the objectives of the USAEC QA program and any additional quality control processes implemented during the RI.

3.2.1 Off-Site Laboratory Certification

In accordance with the 1990 USATHAMA QA Program, laboratories were required to demonstrate competency by performance demonstration of the PAL analytical methods conducted in association with field investigations. The USAEC requires that a laboratory demonstrate proficiency in performing USAEC methods for specific analytes. Analytical methods are based on USEPA procedures (USEPA 1983; 1986). Laboratories demonstrate proficiency by submitting data from runs of pre-certification calibration standards.

Performance samples are then sent for analysis to the laboratory by the USAEC. The true concentrations of the analytes in the performance samples are unknown by the laboratory. The data obtained from the analyses of these samples are then sent to the USAEC to determine the laboratory's precision and accuracy. Qualifications to perform USAEC methods are awarded to laboratories based on this performance. Certified Reporting Limits (CRLs) are also determined through this process. A method code associated with each USAEC analysis and laboratory is then assigned and reported with the results. Listings of USAEC certified analytical methods used during the RI, target analytes, and CRLs are presented in Appendix D, Table D-1.

Some standard USEPA methods such as hardness, total organic carbon (TOC), TPHC, and total suspended solids (TSS) have no associated USAEC certification. The USAEC recognizes standard USEPA protocols or internal laboratory methods for these analyses. Laboratories are required to submit information on procedures for analyzing samples using these methods to the USAEC Chemistry Branch before they are implemented. Listings of USEPA analytical methods used during the RI and project reporting limits are presented in Appendix D, Table D-1 for the 1995 and 1996 Field Investigations.

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3.2.2 Off-Site Laboratory Methods Quality Control

All field samples sent to the laboratory were organized into lots which were assigned a lot code. Each lot consisted of the maximum number of samples, including QC samples, that can be processed through the rate limiting step of the method during a single time period (not exceeding 24 hours). Associated with each lot were laboratory control samples. Control samples were spikes of high and low concentrations of specific analytes that help monitor ESE's precision and accuracy. The recoveries of these spikes were plotted on control charts generated by ESE and submitted to the USAEC. Data generated during the performance demonstration process were used to calculate a mean of the recoveries. Control and warning limits were statistically generated by the USAEC Chemistry Branch to help measure laboratory data quality. Control charts are generated with each lot providing a continuous benchmark for trend evaluation of laboratory performance.

Method blanks were also analyzed at ESE to evaluate the potential for target analytes to be introduced during the processing and analysis of samples. One method blank was included with each analytical lot. Because analytical lots included samples from several areas, method blank results are presented and discussed for all AOCs investigated during the RI.

3.2.3 Data Reduction, Validation, and Reporting

Initial responsibility for accuracy and completeness of Devens analytical data packages rested with ESE. All data submissions to the USAEC first underwent a review process, including checks on the data quality, which evaluated completeness of the ESE data, accuracy of reporting limits, compliance with QC limits and holding times, and correlation of ESE data to associated laboratory tests.

The following items were also validated by ESE before submission to the USAEC:

- COC records;
- instrument printouts for agreement with handwritten results;
- calibration records to ensure a particular lot is associated with only one calibration;
- chromatograms and explanations for operator corrective actions (such as manual integration);
- standard preparation and documentation of source;

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- calculations on selected samples;
- notebooks and sheets of paper to ensure all pages were dated and initialed, and explanations of procedure changes;
- GC/matrix spike (MS) library search of unknown compounds; and
- transfer files and records to ensure agreement with analysis results.

3.2.4 Data Reporting

After review and validation by ESE, the data were encoded for transmission into the USAEC's Installation Restoration Data Management Information System (IRDMIS) as Level 1 Data. IRDMIS, a computerized data management system used by the USAEC, is described in detail in Subsection 3.3. Once the data were entered into the system, a group and records check was completed. Data were then transferred to USAEC's data management contractor. During this phase, the data were elevated to Level 2. Another group and records check was performed and the data were reviewed by the USAEC Chemistry Branch. When errors were identified, the data were returned to ESE for correction. Control charts were produced by ESE that plotted recoveries of high and low concentrations of laboratory control spikes of the target analytes. The control charts provided the USAEC with information about the accuracy of the analytical methods performed by ESE. Once data were reviewed by the USAEC Chemistry Branch, the determination was made on a lot-by-lot basis whether the data were acceptable. Qualifiers may be added to results to identify quality issues related to data quality. Two types of qualifiers are used for data entered into the IRDMIS data base. Qualifiers include flagging codes which are entered by the subcontract laboratory and data qualifiers which are entered by USAEC Chemistry Branch during the secondary review process described in Subsection 3.2.2. Flagging codes and data qualifier codes used on the IRDMIS are described in Table 3-1. The data that were accepted were then elevated to Level 3 and made available to USAEC personnel and HLA by modern to a main frame computer. Data summary tables presented in this report were generated using the IRDMIS data base. Off-site results are presented in Section 7.0 and Appendix L-2.

3.2.5 Field Quality Control Samples

Field QC samples which were collected during the RI included a field blank exploration and decontamination, MS/matrix spike duplicates (MSDs), field duplicate samples, rinse blanks and trip blanks.

Before field investigations were initiated, a sample of water, collected from the source, was used for sampling equipment decontamination. The water source for the RI at AOCs 57 was the South Post Water Point (Well D-1). For the purpose of off-site laboratory QC, this was identified as the field blank (source water sample). The field blank data were sent to the USAEC Chemistry Branch where approval was granted for the use of this water in decontamination procedures. The information gained from the analysis of the field blank provided data on the quality of the USAEC-approved water used in the decontamination of the sampling equipment.

As specified in the Fort Devens POP, (ABB-ES, 1995), MS/MSDs were spiked and analyzed for PAL inorganics, and pesticides/PCBs, as well as several USEPA Methods for hardness, total petroleum hydrocarbons, (TPHC) by USEPA Methods 9071 and 8105, TOC, total phosphate, nitrate and nitrite-nitrogen, and kjeldahl-nitrogen. HLA personnel made the determination of which samples were to be designated as MS/MSDs. This was noted on the COC forms submitted to ESE.

Samples designated as MS/MSDs were spiked at the off-site laboratory with specified concentrations of analytes to determine matrix effects based on USAEC and USEPA method guidelines. MS/MSD data were also used to assess the accuracy of the analyses used. MS/MSD samples were collected at a rate of one set per 20 samples. During the 1995 RI field investigations, samples were collected from AOCs 57, 69W and 57 simultaneously. Therefore, assessments of MS/MSD data, contained in Appendix D, were made for these AOCs collectively.

Field duplicate samples were also collected at a rate of one per 20 field samples. The purpose of duplicate sample analysis was to assess the sampling and off-site laboratory precision for particular methods. Since two AOCs were investigated simultaneously during the RI field effort, field duplicates were collected for each media sampled at each AOC. Duplicate data were assessed collectively for the RIs. Duplicates submitted to ESE were analyzed for the same parameters as the corresponding field samples. Duplicate sample results are presented in Appendices D.

Rinse blanks were collected and analyzed for PAL analytes and TPHC by USEPA Methods 418.1 and 8015. Rinse blanks consisted of previously analyzed deionized water which was poured over sampling equipment. Analysis of this water provided information used to

evaluate the potential for sample contamination during sample collection. The results were also used to assess decontamination procedures for the sampling equipment. As specified in the Fort Devens POP (ABB-ES, 1995), rinse blanks were collected at a rate of one per 20 samples. Rinse blank results from the RIs are included in the data quality reports in Appendices D. Discussions regarding rinse blank contamination are relevant to both AOCs investigated during the RIs.

For every shipment of VOC samples to ESE, trip blanks accompanied the samples. The purpose of analyzing trip blanks was to determine if there was any VOC cross contamination during the shipment and handling of samples. The trip blanks consisted of previously analyzed deionized water that was bottled at ESE. Trip blanks were shipped in sealed containers to the job site. As needed, trip blanks were then included with shipments of VOC field samples. Since the VOC field samples were taken from AOCs 57, 69W, and 57 simultaneously, trip blank data collected was associated with both AOCs. Data were included for trip blanks sent with any samples from all AOCs investigated during the RI. Trip blank data are presented in Appendices D.

3.2.6 Off-Site Analytical Data Quality Evaluation

Off-site data quality reviews were conducted by the project chemist for results generated during the RI. In addition to USAEC laboratory data reviews described in Subsection 3.2.2, precision and accuracy of results were assessed by reviewing MS/MSD results, field duplicate results, and surrogate recovery. QC sample results were compared to goals outlined in the Fort Devens POP (ABB-ES, 1995) and USEPA Region I validation guidelines (USEPA, 1988; USEPA, 1989). QC blank results were also evaluated as discussed below, to assess the potential for sample contamination during sample collection or at the off-site laboratory. Detailed discussions of these reviews are contained in Appendices D. Conclusions on the precision and accuracy of analytical measurements are summarized in Subsection 7.1.2.

Off-site laboratory data collected during the RIs at Devens were evaluated for possible offsite laboratory or sampling-related contamination. This evaluation did not include validation according to USEPA guidelines. Sample results reported and discussed in this report were not adjusted for reported analytes that were also detected at similar concentrations in blanks associated with that sample; action levels were not established, and the 10X rule was not applied to compounds considered by the USEPA to be common

laboratory contaminants. Examples of these contaminants include the VOCs acetone, methylene chloride, and the phthalate semivolatile organic compounds (SVOCs). Likewise, action levels for other analytes using the 5X rule application were not established. Analytes that would have been below these action levels were not removed from the data as they would have been in the USEPA validation process.

General trends relating to blank and sample contamination were examined. Comparison of blank data with results from the entire data set are discussed as a data assessment. Assessments are made based on analyte detection in blanks, the frequency of the detection and the concentrations of these analytes. A summary of blank contamination is presented in Subsection 7.1.2 of this report. Some analytes are interpreted to represent non-site related contamination in the contamination assessments presented in Section 7.0.

3.3 CHEMICAL DATA MANAGEMENT

Chemical data from the AOC were managed by HLA's Sample Tracking System and the USAEC's IRDMIS. These systems are described in the following sections.

3.3.1 Sample Tracking System

HLA employed its computerized Sample Management System to track environmental samples from field collection to shipment to the off-site laboratory. HLA also tracked the status of analyses and reporting by the off-site laboratory.

Each day, the field sampling teams carried computer-generated sample labels into the field that stated the sample control number, sample identification, size and type of container, sample preservation summary, analysis method code, and sample medium. The labels also provided space for sampling date, time, depth (if applicable), and the collector's initials to be added at the time of collection.

After collection in the field, the samples were stored on ice for transport back to HLA's field office. Samples were temporarily stored in the HLA field office refrigerator. They were checked-in on the field office computer, and the collector's initials and the sampling date and time were entered. The system would then indicate the sample status as "COLLECTION IN PROGRESS."

When the samples were prepared for shipment, they were "RELEASED" by the sample management system. Upon request, the system printed an Analysis Request Form (ARF) and a COC, which were signed and included with the samples in the shipment. The system would then indicate the sample status as "SENT TO LAB."

This system substantially reduced the time required for preparation of sample tracking documentation, and it provided an automated record of sample status.

After shipment of samples to the off-site laboratory, HLA continued to use the sample tracking system to track and record the status of the samples, including the date analyzed (to determine actual holding times), the date a sample results transfer file was established by ESE, and the date the sample results transfer file was sent to IRDMIS (Subsection 3.3.2)

3.3.2 Installation Restoration Data Management Information System

IRDMIS is an integrated system for collection, validation, storage, retrieval, and presentation of data of the USAEC's Installation Restoration and Base Closure Program. It uses personal computers (PCs), a UNIX-based minicomputer, printers, plotters, and communications networks to link these devices.

For each sample lot, HLA developed a "provisional" map file for the sample locations, which was entered into IRDMIS by Potomac Research, Inc. (PRI), USAEC's data management contractor.

Following analysis of the sample lot, ESE created chemical files using data codes provided by HLA, and entered the analytical results (Level 1) on a PC in accordance with the User's Manual (PRI, 1993). For each sample lot, a hard copy was printed and was reviewed and checked by ESE's Laboratory Program Manager. ESE created a transfer file from accepted records which was sent to HLA (Level 2). HLA performed a group and record check and sent approved records in a chemical transfer file to PRI. PRI checked the data and, if accepted, entered it into the IRDMIS minicomputer (Level 3). Level 3 chemical data are the data used for evaluating site conditions and are the data used in this AOC 57 RI report and human health risk assessment.

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4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) IDENTIFICATION

CERCLA was enacted by Congress in 1980, establishing the Superfund program. The regulations implementing this program are found in 40 CFR Part 300, also known as the National Contingency Plan (NCP). CERCLA was amended in 1986 by SARA, which mandated that the level or standard of control specified in a remedial action be "at least that of any ARAR standard, requirement, criteria, or limitation under any federal environmental law, or any more stringent standard, requirement, criteria or limitation promulgated pursuant to a state environmental statute." SARA also established that the requirements of the NCP apply to federal facilities.

The purpose of the RI was to determine the nature and distribution of site-related soil and groundwater contamination at AOC 57 Areas 2 and 3. In order to evaluate whether there is a potential threat to human health and the environment, preliminary ARARs are identified in this section and will then be compared to site-specific data. ARARs are federal and state human health and environmental requirements used to (1) evaluate the distribution of site impacts and the appropriate extent of site cleanup; (2) define and formulate remedial action alternatives; and (3) govern implementation and operation of the final remedy.

Identification and evaluation of ARARs is an iterative task, necessary throughout the remedial response process. Therefore, the preliminary lists of requirements identified for AOC 57 Areas 2 and 3 and their relevance may change as more information is obtained, as the preferred alternative is chosen, and as the design and approach to remediation becomes more refined.

<u>Applicable Requirements</u> - Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance that have jurisdiction at a site. An example of an applicable requirement is the use of the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) drinking water standards for a site where hazardous substances have caused water in a public water supply distribution system to become contaminated.

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<u>Relevant and Appropriate Requirements</u> - Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a site, address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the particular site. For example, MCLs for drinking water would be relevant and appropriate requirements at a site where hazardous substances are found in or could enter drinking water classified as a current or future drinking water source. When a requirement is found to be relevant and appropriate, it is complied with to the same degree as if it were applicable.

<u>To be Considered (TBC) Material</u>. Non-promulgated advisories or guidance issued by the federal and state government are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with ARARs as part of the site risk assessment, and may be used in determining the level of cleanup for protection of human health or the environment.

ARARs that pertain to the remedial response can be classified into three categories: chemical-, location-, and action-specific. The following subsections provide an overview of these ARARs.

4.1 CHEMICAL-SPECIFIC ARARS

Because of their site-specific nature, the identification of ARARs requires an evaluation of the federal, state, and local environmental regulations with respect to chemicals of concern and site characteristics. Chemical-specific ARARs generally involve health- or risk-based numerical values or methodologies that establish site-specific acceptable chemical concentrations or amounts. These values are used to develop action levels or cleanup concentrations.

4.1.1 Groundwater

Table 4-1 sets forth the federal chemical-specific ARARs and TBC information for groundwater. USEPA SDWA MCLs are legally applicable to contaminants found in public water systems that have at least 15 service connections or serve an average of at least 25

people daily at least 60 days per year. Even when not legally applicable, MCLs may be relevant and appropriate to groundwater remediation. Maximum contaminant level goals (MCLGs) are non-enforceable, health-based goals at which no known or anticipated adverse effects on health will occur and are considered TBCs. Table 4-1 also includes the current version of USEPA Region III risk-based concentrations (RBCs) which are commonly used as TBC information at CERCLA sites. The surface water criteria set forth in Table 4-1 are TBC information and will only be applicable if a discharge to surface water will be part of the groundwater remedial action.

Table 4-2 sets forth the state chemical-specific ARARs and TBC information for groundwater. The Commonwealth of Massachusetts has developed drinking water standard and guidelines, expressed in terms of maximum levels of contaminants allowed in drinking water. Groundwater data from AOC 57 will be applied to Massachusetts Maximum Contaminant Levels (MMCLs), Massachusetts Class I groundwater quality standards, and/or USEPA Region III RBCs for tap water.

4.1.2 Soil

Table 4-3 sets forth the soil screening levels (TBCs) from the current USEPA Region III RBC documents.

4.1.3 Massachusetts Contingency Plan

The NCP provides that CERCLA response actions must comply with environmental and public health laws and regulations to the extent they are substantive (i.e., pertain directly to actions or conditions in the environment), but do not need to comply with those that are administrative (i.e., mechanisms that facilitate the implementation of the substantive requirements).

The provisions of the MCP, 310 CMR 40.0000 (January 13, 1995) are mostly administrative in nature and, therefore do not have to be complied with in connection with the response actions selected for AOC 57 Areas 2 and 3. Further, the MCP contains a specific provision (310 CMR 40.0111) for deferring application of the MCP at CERCLA sites. As stated in the MCP, response actions at CERCLA sites are deemed adequately regulated for purposes of compliance with the MCP, provided the MADEP concurs in the CERCLA Record of Decision (ROD).

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However, some provisions of the MCP contain substantive requirements that may be ARARs. Section 310 CMR 40.0940 sets forth three methods of risk characterization. Section 310 CMR 40.0942 provides that any of the three methods may be used, subject to certain specified limitations. MCP Method 1 establishes specific numerical standards for certain listed contaminants (see 310 CMR 40.0974.-0975). Since MCP Method 1 contains promulgated numerical standards, it may be an ARAR if this method is selected.

MCP Method 3 does not contain substantive numerical standards; rather it provides a risk characterization methodology to determine the appropriate cleanup level (see 310 CMR 40.0991.-0996). Because MCP Method 3 is a methodology and does not contain substantive standards, and because it defines protectiveness in a way which is inconsistent with the CERCLA NCP, Method 3 is not an ARAR which has to be met. Therefore, these standards of the MCP do not apply to the remedial response at AOC 57.

4.2 LOCATION-SPECIFIC ARARS

Location-specific ARARs represent restrictions placed on the concentration of hazardous substances or the conduct of activities because of the location or characteristics of a site. These ARARs set restrictions relative to special locations such as wetlands, floodplains, sensitive ecosystems, as well as historic or archeological sites, and provide a basis for assessing existing site conditions. Table 4-4 lists location-specific federal and state requirements.

Some of the location-specific ARARs for areas such as wetlands and floodplains may or may not be applicable, or relevant and appropriate, depending on the remedial action selected because the regulations do not apply unless some activity is conducted in a certain defined area.

4.3 ACTION-SPECIFIC ARARS

Action-specific ARARs involve design, implementation, and performance requirements that are generally technology- or activity-based. Action-specific ARARs, unlike location- and chemical-specific ARARs, are usually technology- or activity-based limitations that

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direct how remedial actions are conducted. After remedial alternatives are developed, the evaluation of action-specific ARARs is one criterion for assessing the feasibility and effectiveness of compliance with proposed remedial alternatives. The applicability of this set of requirements is directly related to the particular remedial activities selected for the site. Table 4-5 represents an overview of potential action-specific ARARs that may or may not ultimately be applicable to AOC 57.

4.4 BACKGROUND CONCENTRATIONS

As a means to evaluate concentrations of inorganic analytes detected in samples collected as part of each phase of investigation, background concentrations were calculated for the Fort Devens installation. Background concentration calculations were based on analytical data results gathered from soil and groundwater samples collected throughout the Devens installation, selected as representative of background (non-contaminated) conditions. Although most of the calculations include assumptions on both the distribution of chemical concentrations and on the selection of representative samples that are not statistically rigorous, the results are considered representative of actual background concentrations at Devens.

For soil, chemical data gathered from 20 soil samples collected by Ecology & Environment, Inc. (E&E) as part of their Group 1A and 1B investigation activities were used. The samples were collected from the major soil associations throughout Devens specifically to establish background concentrations of inorganic analytes in soil. The background soil samples were collected from locations that were visually undisturbed, at least 50 feet from any road, and 300 feet from any known SA.

The calculations were performed on 22 of the 23 PAL inorganic analytes (no data was available for thallium). For analytes that were not detected in the majority of soil samples, the detection limit for that analyte was selected as the background concentration. Sample location, data ranges, mean values, details of calculations, and calculated background concentrations are summarized in Appendix L.

For groundwater, HLA selected 10 representative groundwater samples collected from the Round One groundwater sampling events, completed in 1992, for Groups 2, 3, 5, 6 and 7 for the purpose of calculating background inorganic analyte concentrations in groundwater.

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Representative groundwater samples were selected from specific monitoring wells located upgradient of a SA, exhibiting low TSS and/or low aluminum concentrations. Aware that elevated TSS concentrations artificially elevate inorganic analyte concentrations, HLA selected samples that exhibited TSS concentrations on the same order of magnitude as the South Post Water Point (Well D-1). Because a close correlation between TSS concentrations and aluminum concentrations was observed in all the groundwater samples analyzed, the aluminum concentration was used as an alternate selection criterion in the absence of TSS data. The concentration values detected in the ten samples were calculated using the same assumptions on outliers and detection limits applied to the soils background concentrations, data ranges, mean values, and details of the calculations are also provided in Appendix L.

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5.0 AOC 57 REMEDIAL INVESTIGATION

5.1 BACKGROUND AND CONDITIONS

AOC 57 consists of three areas, Area 1, Area 2, and Area 3 located south of Barnum Road, on the Main Post south of Building 3713 (Figures 5-1 and 5-2). A storm drain outfall which collects rainfall from the paved areas around Building 3713 has been designated Area 1 (Figure 5-3). The runoff from the storm drain flows to the outfall at Area 1, and eventually into Cold Spring Brook.

Area 2 is located 800 feet northeast of Area 1, and adjacent to a vehicle storage yard associated with the former motor repair shops located in Buildings 3757 and 3758. The nearby Building 3756 served as a mess hall and was later converted to a general storehouse. This area formerly consisted of an eroded drainage ditch created by periodic rain runoff. The area has been recently regraded and a permanent drainage swale has been installed. Runoff drains into the swale and discharges east to Cold Spring Brook.

On February 13, 1977, Fort Devens personnel at Building 3713 noticed No. 4 fuel oil flowing from an overfilled UST into a nearby storm drain (Biang et al., 1992; DFAE, 1977). An estimated 50 to 100 gallons of oil entered Cold Spring Brook through the Area 1 outfall. Containment dikes and absorbent booms were set up across Cold Spring Brook adjacent to Area 2, and approximately 3,000 gallons of mixed oil and water were recovered from the swamp (DFAE, 1977).

A portion of this spill reportedly flowed across Barnum Road to Area 2. However, topographic relief in the spill area and Area 2 is such that the oil could not have flowed overland to Cold Spring Brook.

Area 3 is located approximately 600 feet northeast of Area 2 on a strip of land between former fenced in motor pools to the north and the forested Cold Spring Brook floodplain to the south. This area was the site of past disposal of vehicle and maintenance related wastes.

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5.2 SUMMARY OF PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS

The following subsections summarize previous investigations and removal actions performed by Devens contractors at AOC 57. The text discussion of previous investigation is provided chronologically. A brief summary of analytical data is presented to demonstrate the need for subsequent investigations at the site. A complete assessment of the analytical data is presented in Section 7.0 of the RI Report. The scope of each investigations' activities is summarized in Table 5-1.

5.2.1 1992 Site Investigations

HLA conducted an SI at Areas 1 and 2 of AOC 57, then SA 57, in September 1992. The objective of the SI was to determine the presence or absence of environmental contaminants in the different environmental media at AOC 57 as a result of the February 1977 fuel oil spill. A detailed description of the results of the SI are presented in the Revised Final Groups 2, 7, and Historic Gas Station SI Report (ABB-ES, 1995b).

Samples of surface soil, surface water, and sediment were collected from Areas 1 and 2 during the SI. Polycyclic aromatic hydrocarbons (PAHs) and TPHC possibly associated with fuel oil were detected in surface soils at Area 1 (57S-92-01X through 57S-92-03) (Figure 5-4). However, the Preliminary Risk Evaluation (PRE), which was conducted to evaluate potential exposure to detected PAH compounds and TPHC, indicated that there was no unacceptable risk for the presumed commercial/industrial site reuse. The Army recommended that Area 1 be further investigated as part of the installation-wide AREE 70 storm sewer study.

At Area 2, naphthalene and TPHC were detected in surface soils during the SI (57S-92-06X through 57S-92-08X) (Figure 5-4). Fingerprint analysis of soil from Area 2 indicated that contaminated soil was most likely derived from lubricating oil, possibly from the release of vehicle crank case oil. Given this finding, the contaminants found at Area 2 are not likely related to the 1977 release of No. 4 fuel oil. Results of the human health and ecological PREs indicated that the chemical hazards at Area 2 were not significant. However, the PREs were performed prior to promulgation of applicable MCP standards. Area 2 surface soil data is presented in Table 5-2.

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Surface water and sediment samples were collected during the SA 57 SI (57D-92-01X and 57D-92-02X) as well as during the Group 3 SI (G3D-92-01X through G3D-92-03X) conducted in June of 1992. Analyses of these samples showed similar levels of VOCs, SVOCs, TPHC, and various inorganics in both the upstream and downstream samples. Based on these data it was concluded that SA 57 may have impacted sediment quality in Cold Spring Brook. However, analytical results showed that additional contamination was entering Cold Spring Brook from a source further south (upstream). This was further investigated during the AREE 70 investigation and the Lower Cold Spring Brook SI. Surface water and sediment data from the previous investigations are provided in Appendix E.

5.2.2 AREE 70 Investigation

The AREE 70 investigation (ADL, 1994a) gathered information on 55 storm drain systems and three surface water bodies, and identified potential sources of contamination that were not identified through previous investigations. Included in the AREE 70 evaluation was Storm Drain System 6 (AOC 57 Area 1). Three sediment and two water samples were collected at three locations within the drainage ditch (SSD/SSW-93-06A, SSD/SSW-94-06B, and SSD-94-06C). Of these samples only SSD/SSW-93-06B is located within AOC 57 (Figure 5-4). Analyses of the surface water and sediment samples indicated elevated levels of arsenic, chromium, and lead in sediment and arsenic and lead in water. Seventeen SVOCs were reported in SSD-93-06B. This sample also had the highest concentration of total SVOCs at approximately 59.8 μ g/g. Results of the sampling were incorporated into the Lower Cold Spring Brook Study ecological PRE (see Subsection 5.2.4). AREE 70 surface water and sediment analytical data are provided in Appendix E.

5.2.3 Area 2 Soil Removal Activities

The PREs performed in conjunction with the 1992 Groups 2 and 7 SI indicated that chemical hazards at Areas 1 and 2 were not significant. However, the PREs were performed just prior to promulgation of MCP soil standards. In consideration of the new standards, the Army proposed that a limited soil removal (focused on TPHC) be conducted at Area 2.

In October of 1993 eight additional surface soil samples (57S-93-10X through 57S-93-17X) were collected from the drainage ditch area and screened for TPHC to aid in determining

the extent of contamination requiring removal (Figure 5-4).

A removal action performed by OHM began on August 26, 1994 and continued until September 12, 1994. Soil was excavated using standard excavating equipment. Soil samples were collected for field analysis of TPHC as each area was excavated. TPHC was detected in these samples up to a maximum concentration of 74,208 mg/kg (Tables 5-4 and 5-5). Black, oily soil was detected at approximately 18 inches below ground surface (bgs) at the base of the slope.

Continued excavation efforts revealed stained soil laterally and at depths in excess of original estimates. A trench was excavated to the water table in the southern-most portion of Area 2 to define the extent of contamination (Figures 5-4 and 5-5). An oily sheen was observed on water in the trench.

The trench was not successful in determining the limits of contamination, so test pits were subsequently excavated outside the previously excavated area. Locations of the test pits are identified in Figure 5-4 and 5-5. Soils collected from the test pits were field-screened to determine the extent of TPHC-contaminated soil. Soon after starting the test pit excavation, it became clear that contamination extended well beyond the limits originally estimated, and the removal action was suspended until Area 2 could be better characterized. A total of approximately 1,300 cubic yards of soil was ultimately excavated from Area 2, before it was lined with 6-mil polyethylene, backfilled with clean soil, and covered with an erosion control blanket. A drainage swale was constructed and lined with 6-inch riprap to channel surface water runoff to the Cold Spring Brook wetland. Subsequently, SA 57 Area 2 was administratively transferred to the RI/FS process and redesignated AOC 57.

5.2.4 Lower Cold Spring Brook Study

In 1994, HLA conducted an SI at Lower Cold Spring Brook to evaluate surface water and sediment quality. Samples were collected from 23 locations in Lower Cold Spring Brook and 11 locations in storm drain ditches and swales. A portion of the SI surface water and sediment samples were collected from Cold Spring Brook at locations both upstream and downstream of AOC 57 Areas 1, 2, and 3 (Figure 5-6). Analytical data from these samples are presented in Appendix E. The findings of this SI were presented in the "Lower Cold Spring Brook SI Report" (ABB-ES, 1995c).

The SI produced no evidence that analytes in surface water pose risks to aquatic receptors. Furthermore, no ecological risks were identified from exposure to contaminated media in several of the storm drain systems including system No. 6 (AOC 57 Area 1). No further study was recommended for Area 1.

Analytical results from the brook in the vicinity of Area 2 indicated that the marsh located upstream of the 1977 containment dike contained sediments with elevated concentrations of VOCs, SVOCs, pesticides, PCBs, and inorganics. TPHC was detected at a maximum concentration of 2,700 mg/kg. SVOCs were detected at concentrations that marginally exceeded screening values, while pesticides, PCBs, and inorganics significantly exceeded screening values. Lead was detected in surface water at a concentration above the Ambient Water Quality Criteria (AWQC). Pesticides and the maximum concentrations of inorganics in sediment were found in the sample from location CSD-94-20X, adjacent to AOC 57 Area 2. The ecological PRE showed no risks to aquatic receptors from surface waters. However, limited ecological risks may be associated with AOC 57 marsh sediments. Relative to the control area, this station contained the poorest habitat. However, macroinvertebrate and aquatic toxicity results did not indicate any increased mortality relative to aquatic receptors.

As a result, it was recommended that Lower Cold Spring Brook in the vicinity of AOC 57 Area 2 be further evaluated during the RI.

5.2.5 Area 1 Contaminated Soil Removal

Although the Lower Cold Spring Brook PRE for Area 1 showed that there were no identifiable ecological risks, it was decided to perform a contaminated soil removal at the outfall to address soil contamination resulting from releases of petroleum oil.

Excavation of outfall soils commenced in February of 1997. Initial removal operations included excavation of a 15-foot by 15-foot area to a maximum depth of 2 feet bgs at the outfall location. Following the initial excavation, four composite samples were collected for on-site TPHC screening. TPHC values in these composite samples ranged between 66 and 271 ppm. Six confirmatory samples (AOC-57, A1-SW1, SW2, SW3, SW4, FL1, DUP) were also collected and submitted for off-site analyses for EPH/VPH and inorganics to verify the on-site screening (Figure 5-7 and Table 5-6).

The EPH $C_{10} - C_{22}$ aromatic fraction in excess of MCP S-1/GW-1 standards was detected in sidewall samples. Based upon these data, an additional three feet of soil was excavated from the sidewalls perpendicular to the outfall pipes and approximately seven feet was excavated from the wall opposite the outfall pipes. The maximum depth of excavation was three feet bgs. Following the second phase of excavation, an additional three confirmatory samples were collected from the sidewalls (AOC 57-A1-SW1/B, SW2/B and SW4/B) (Figure 5-7 and Table 5-6). Confirmatory analytical results for the second round of sampling indicated elevated PAH concentrations in sidewalls AOC 57-A1-SW1/B and SW4/B. A total of 10 PAH contaminants exceeded the applicable MCP S-1/GW-1 standards with the highest concentrations located downstream of the outfall pipes.

A statistical comparison of the arithmetic mean concentration of the PAHs indicated that the types and concentrations of PAHs in sediments at the Area 1 outfall are consistent with concentrations at various outfalls along Cold Spring Brook (Weston, 1998). This analytical data strongly indicates that fuel oil related contamination at the outfall was successfully removed, and what remains in soil and sediment at the outfall are PAHs that are likely related to runoff from paved, trafficked areas along Barnum Road. This type of PAH contamination, which cannot feasibly be eliminated from runoff from asphalt paved areas, is specifically exempted from MCP requirements due to its relative ubiquity at these types of outfalls.

5.3 REMEDIAL INVESTIGATION PROGRAM OBJECTIVES

Based upon the conclusion and recommendations of the previous investigations an RI was planned and performed at AOC 57 Area 2 in 1995. During the 1995 RI field work additional explorations were conducted at a location approximately 600 feet northeast of Area 2 based upon potential soil staining observed in historical photographs. The explorations showed that this was the site of historical disposal of vehicle maintenance waste. The site was designated AOC 57 Area 3 and became the subject of the 1996 field investigation.

The Draft RI Report was issued following the 1996 field investigation. As a result of regulatory comments additional sampling was performed in 1998 at Areas 2 and 3. The purpose of the 1998 supplemental sampling was to further delineate the downgradient extent of contamination.

As a result of the data obtained from the 1998 field investigation, a contaminated soil removal was performed in 1999 at Area 3.

5.3.1 Technical Objectives

The following subsections present the technical objectives of the sampling and analysis programs completed for the RI at AOC 57. The RI included the following activities:

5.3.1.1 Background Historical Research. As a means to further understand and better characterize the contaminant release scenarios at AOC 57, HLA researched historical site use, past and present waste disposal practices, nearby in-use and abandoned underground storage tanks, and other potential sources of contaminants. The results of this research effort were used to guide the selection of sampling locations and laboratory analyses. Information gathered under this research activity on current and future uses of the site were incorporated into the assessment of human health and environmental risk included in Section 9.0 of this report.

5.3.1.2 Geophysical Survey. After conducting the historical research and prior to exploratory work, a geophysical survey was conducted at AOC 57/Area 2 and Area 3 to rapidly gather AOC-wide, non-intrusive data on subsurface features. The survey focused on identifying the location of potential subsurface utilities such as underground storage tanks and pipelines, as well as buried materials that may have contributed to the release of contaminants. The geophysical survey results also provided information on subsurface geology which aided in the placement of test pits, soil borings and monitoring wells.

5.3.1.3 Test Pits. Because of the inherent complexity in the distribution of contaminants as observed during the 1992 SI and subsequent removal action, a test pitting program was conducted to better define the boundaries of contaminant migration and characterize the vertical distribution of contaminants within the overburden. Using the test pits excavated during the soil removal action as a basis, test pits were located inside and outside the presumed limits of contamination for the purpose of evaluating potential contaminant

sources and migration pathways, as well as estimating volumes of contaminated soil. Soil samples were collected from each test pit and analyzed for various chemical parameters to characterize the concentration and distribution of individual compounds. Test pits were also used to define the contaminant source area at Area 3.

The results of the test pitting program were used with other RI data to assess risk to potential receptors, to establish clean-up goals, and to evaluate remedial action alternatives.

5.3.1.4 TerraProbeSM Borings. Soil and groundwater samples were collected from TerraProbeSM points to further define the lateral and vertical distribution of contamination in Area 3. Field analytical data obtained from the TerraProbeSM samples were used to aid in placement of soil borings and monitoring wells

5.3.1.5 Soil Borings, Surficial and Subsurface Soil Sampling. Soil borings were advanced at Areas 2 and 3 to allow the collection of additional subsurface soil samples for chemical analysis. Borings were drilled in the area of critical interest based on the test pit excavation findings to further define the limits of contaminant migration. The results were used to support both the contamination assessment and the human health and ecological risk assessments.

5.3.1.6 Groundwater Monitoring Wells and Piezometers. Evidence collected during the suspended 1994 soil removal effort at AOC 57/Area 2 revealed free phase product in soil at the water table suggesting the possibility of groundwater contamination in the form of dissolved and free-phase contaminants. Little information on local groundwater flow and contamination was available. Characterizing the nature of potential groundwater flow and contamination in the area around AOC 57/Areas 2 and 3 was of critical importance to defining potential receptors. The installation of groundwater monitoring wells and piezometers at AOC 57/Areas 2 and 3 provided information on the distribution of contaminants and characterization of aquifer hydraulic properties.

Wells were installed in locations selected to provide representative samples from upgradient and downgradient groundwater. Piezometers were located to evaluate the hydraulic dynamics between groundwater and Cold Spring Brook as part of the assessment of potential downgradient receptors. Soil samples collected during the installation of these monitoring wells and piezometers were used to characterize soil stratigraphy, also useful in developing remedial alternatives.

5.3.1.7 Sediment and Surface Water Sampling. In order to characterize the potential for contaminant migration to Cold Spring Brook, sediment and surface water samples were collected from wetland areas near AOC 57/Area 2 and 3 and in Cold Spring Brook. Whole sediment samples were also collected for toxicity testing.

The results of the sediment and surface water sampling program were used with other RI data to delineate the extent of contamination and to assess risk to potential receptors and establish clean up goals.

5.3.1.8 Sample Analysis. Petroleum hydrocarbons appear to be the predominant contaminants present in soil and sediment collected at AOC 57. Elevated concentrations of VOCs, PCBs, lead, and arsenic possibly associated with the petroleum hydrocarbons, have also been detected. Soil, groundwater, surface water, and sediment samples collected from selected locations within test pits, soil borings, monitoring wells, and Cold Spring Brook were analyzed for these and other analytes. Chemical analyses performed during the RI included various field screening techniques designed to provide a preliminary evaluation of contaminant distribution. Sample analysis also included off-site laboratory analysis designed to provide a higher level of accuracy in evaluating contaminant distribution, as input to the human health and ecological risk assessments, and remedial alternatives development. The field and off-site laboratory analytical program enhanced and built upon efforts begun under previous investigations at these sites.

Toxicity testing was also conducted on selected whole sediment samples collected from the wetland adjacent to AOC 57/Area 2. The test results are used to evaluate adverse effects associated with exposure of selected freshwater invertebrate species to whole sediment. These results will be used to supplement the chemical data used in the ecological risk assessment.

5.3.1.9 Ecological Survey and Wetlands Investigation. A qualitative ecological survey was conducted to identify potential ecological receptors and exposure pathways in Cold Spring Brook and its floodplain at AOC 57 Areas 1, 2, and 3. Information from the qualitative survey was incorporated into the baseline ecological risk assessment. The results of the survey provide information necessary for evaluating and developing cost estimates for remedial alternatives.

5.3.1.10 Baseline Risk Assessment. A baseline risk assessment, in accordance with USEPA risk assessment guidelines, was conducted for AOC 57/Areas 1, 2, and 3 to evaluate both actual and potential human health and ecological risks associated with soil, groundwater, surface water, and sediment contamination. The components of the two risk assessments include the following: data summarization and selection of chemicals of potential concern (CPCs); hazard assessment; ecological characterization; exposure assessments; ecological effects assessment; toxicity assessment; risk characterizations; comparison of analytical data to health standards and guidelines; and qualitative uncertainty analyses. The risk assessments are presented in Section 9.0 of this report.

5.3.1.11 Remedial Alternatives Development/Screening. A range of remedial alternatives are developed in the FS by assembling combinations of technologies to address the response objectives. The range of alternatives include no action, actions that reduce contaminant migration or minimize exposure, and treatment alternatives that address the principal threats and eliminate or minimize the need for long-term management. These alternatives will then be screened using effectiveness, implementability, and cost criteria to limit the number of alternatives to be evaluated in detail, while still preserving the range of options.

5.3.1.12 Detailed Analysis of Alternatives. A limited number of alternatives remaining after the screening process will be evaluated based on seven of the nine CERCLA criteria in the FS. The criteria of state and community acceptance will be evaluated upon receipt of state and public comments. Each alternative is evaluated individually, and then the alternatives are compared against each other to provide decision-makers with information that will assist them in selecting the best alternative for remediation of the site.

5.3.2 Data Quality Objectives

The procedures of the Quality Assurance (QA) Objectives presented in Section 3.0 of Volume I of the Fort Devens POP (ABB-ES, 1995b) were followed during the RI/FS field programs at AOC 57/Areas 2 and 3. This subsection describes a general scope of work, data quality objectives (DQOs) and the QA/QC approach.

Analyses were conducted on samples collected from AOC 57/Areas 2 and 3 to evaluate the nature and distribution of the contaminants detected during previous investigations. On-site field analysis conform with the guidelines presented in Subsection 4.6 of Volume I of the

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Fort Devens POP. Off-site laboratory analytical procedures are presented in Section 3.0 and Appendix D of this report and Section 7.0 of Volume I of the POP. The Laboratory QA Plan and the USAEC Performance Demonstrated Analytical Methods procedures are presented in Appendices B and C, respectively, in Volume II of the Fort Devens POP (ABB-ES, 1995b).

The USEPA in 1993 identified two general levels of analytical data quality (USEPA, 1993), to replace the five previously described data quality levels (USEPA, 1987). One of the levels, Screening with Definitive Confirmation, generally comprises field screening and analysis, and encompasses former USEPA 1987 DQO Levels I and II. Activities conducted under the AOC 57 RI which fall into this category include basic field measurements for pH, conductivity, temperature, dissolved oxygen, turbidity, and PID measurements, as well as any on-site analyses. The other general level of data quality, Definitive Data, generally comprises off-site laboratory analysis using CLP RAS or other published USEPA methods, and includes former USEPA 1987 DQO Levels III, IV, and V. Laboratory methods which have been performance-demonstrated under procedures outlined in the USATHAMA QA Plan (USATHAMA, 1990) fall into this level. This level includes off-site water quality parameter and other parameters where USAEC guidelines are not applicable, and off-site laboratory analyses for PAL organics and inorganics.

With the exception of the 1999 Area 3 source area soil removal, data collected during the RI/FS process (both chemical and geotechnical data) was entered and stored in USAEC's IRDMIS. The subcontract analytical laboratory entered all off-site laboratory chemical data as USAEC Level II data, and HLA was responsible for all geotechnical data. The USAEC was responsible for reviewing and qualifying the USAEC Level II data submitted by the subcontract laboratory, and elevating the chemical data to USAEC Level III data. At that point the chemical data is at it's highest data quality and is then available for use in the IRDMIS. USAEC Level III and appropriate USEPA methods data were used in the RI/FS Report.

DQOs were established to support the level of detail required for RI activities. Data generated during the field and laboratory tasks were used to characterize AOC 57 conditions and to perform baseline risk assessments.

DQOs and QC for field measurements and laboratory analyses conform to USAEC and USEPA requirements (as specified in the USAEC Quality Assurance Manual, 1990 and

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Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, 1988).

USAEC requirements and analytical processes are discussed in Section 3.0 of this report. They focus on the use of laboratory control spikes in associated data lots to measure the performance of the off-site laboratory in the use of USAEC methods. Many of the USAEC methods are identical to standard USEPA methods. The certification process, required by laboratories performing USAEC work, is discussed in Subsection 3.2.1. The data review and evaluation process are described in Subsection 3.2.6.

Laboratory data were evaluated for precision, accuracy, representativeness, completeness and comparability (PARCC) in order to meet USEPA Level III requirements. This was accomplished through the collection of field QC blanks such as field blanks, trip blanks and equipment rinsates, and through the evaluation of laboratory blanks such as method blanks. The specific purpose of collecting each of these is discussed in Subsection 3.2.5 of this report. Laboratory control spikes are run in the certification process to generate control charts that help to establish control limits that are used to ensure accuracy of the results. This process is described in the text of the report in Subsection 3.2.5. MS/MSD samples and duplicate samples were also analyzed to meet PARCC data quality objectives. QC sample results are presented in Appendix D. Interpretations on the quality and usability of data are presented in Subsection 7.1.

The precision of the data is a measurement of the ability to reproduce a value under certain conditions. It is a quantitative measurement based on the differences of two values. Precision was evaluated using the RPD of MS/MSD sample pairs and field duplicate sample pairs. Accuracy measurements identify the performance of a measurement system based on tests with known values. The laboratory, sampling, and media effects on accuracy were assessed by reviewing the percent recoveries of spiked analytes for MS/MSDs, laboratory control samples, and surrogate compounds. Evaluations of the precision and accuracy of the data are found in Appendix D and Subsection 7.1.3.

Representativeness refers to the extent to which a measurement accurately and precisely represents a given population within the accepted variation of laboratory and sampling measurements. Collection techniques that obtained samples characteristic of the matrix and location being evaluated were chosen. Historic information was used to identify sample locations. Representativeness was also evaluated using method blanks and field QC sample

data. By evaluating method blank and field QC samples, potential false positive results were identified. Representativeness was also measured by evaluating field duplicate pair precision. Evaluations of data representativeness are presented in Appendix D and Subsection 7.1.2.

Completeness refers to the percentage of usable, valid values obtained through data evaluation. Completeness was determined by the success rate in meeting holding time criteria and acceptance of sample lots by USAEC. Analytical results are considered usable unless otherwise stated in Subsection 7.1.

Comparability is a qualitative assessment describing the confidence with which one data set may be compared with another. Comparability was assured using standard operating procedures for sampling, and by reporting analytical results in standard units.

5.4 SUMMARY OF 1995, 1996, AND 1998 REMEDIAL INVESTIGATION PROGRAMS

RI field investigations were initiated at AOC 57 Area 2 in August of 1995 and continued into November of 1995. In addition to the 23 test pits excavated within Area 2, four test pits were excavated to the east of AOC 57 Area 2. The test pitting was performed based upon apparent soil staining evidenced in historical photographs. Sample analysis results from the four test pits warranted further investigation based upon TPHC and chlorinated VOC concentrations. The area east of AOC 57 Area 2 was designated AOC 57 Area 3 and additional field investigation was performed in August and September of 1996. In an effort to address regulatory concerns, and to better delineate the extent of contamination, additional sampling was performed at Areas 2 and 3 in May of 1998. The RI techniques used at AOC 57 were conducted in conformance with the Revised Final Task Order Work Plans for AOC 57, AOC 63AX, and AOC 69W (ABB-ES, 1996a), The Final RI/FS Task Work Plan Addendum for AOC 57 (ABB-ES, 1996b), the Draft RI/FS Supplemental Work Plan for AOC 57 Areas 2 and 3 (HLA, 1998), and the Fort Devens POP (ABB-ES, 1995b). A summary of investigation activities completed during the RI is presented in Table 5-1. Locations of RI explorations are presented in Figures 5-8 and 5-9.

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The RI field investigation programs for AOC 57 Areas 2 and 3 consisted of:

- geophysical survey consisting of EM-31 and magnetometer at Area 2 and EM-31 and EM-61 at Area 3;
- collection of 16 sediment and 11 surface water samples from Cold Spring Brook near Area 2, and five surface water and sediment samples from the Cold Spring Brook Flood plain at Area 3;
- excavation of 23 test pits at Area 2 (57E-95-01X through 57E -95-20X and 57E-95-25X through 57E-95-27X) and eight test pits at Area 3 (57E-95-21X through 57E-95-24X and 57E-96-28X through 57E-96-31X);
- drilling and sampling of six soil borings at Area 2 (57B-95-01X through 57B-95-06X) and six soil borings at Area 3 (57B-96-07X through 57B-96-12X);
- soil and groundwater sampling of 20 TerraProbeSM points installed at Area 3 (57R-95-01X through 57R-95-06X and 57R-96-07X through 57R-96-20X);
- collection of surficial and subsurface soil samples from 10 locations at Area 2 and from six locations at Area 3;
- installation of nine monitoring wells at Area 2 (57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, through 57M-95-07X, 57M-95-08A, and 57M-95-08B) and six monitoring wells at Area 3 (57M-95-03X and 57M-96-09X through 57M-96-13X);
- installation of three piezometers at Area 2 (57P-95-01A, 57P-95-01B and 57P-98-02X) and two piezometers at Area 3 (57P-98-03X and 57P-98-04X);
- well development of all newly installed monitoring wells;
- performance of a qualitative ecological survey and wetlands investigation of the Cold Spring Brook wetlands and floodplain;

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- two rounds of groundwater sampling from nine new and two existing monitoring wells at Area 2, one round of groundwater sampling from six new and one existing monitoring well at Area 3, and one round of sampling from the piezometers at Areas 2 and 3 and monitoring well 57M-96-11X;
- field analysis of soil and groundwater samples from test pits, TerraProbeSM points, and soil borings from Areas 2 and 3 using a field GC and IR;
- laboratory analysis of environmental samples;
- aquifer conductivity testing of all new monitoring wells; and
- site topographic survey and vertical and horizontal survey of explorations at Areas 2 and 3.

HLA established a project field office in Building 2012 on the former Main Post. The field office was used for equipment storage and maintenance, sample management, shipping and receiving, staff meetings, and communications. A telephone was maintained in the field office and each field crew was issued a hand-held cellular phone. An equipment decontamination pad was constructed near Building 202 also on the former Main Post. HLA and subcontractor staff were briefed about the nature of AOC 57, health and safety information, Devens traffic regulations, and key technical requirements.

HLA began implementation of the AOC 57 field program in August 1995, with equipment mobilization and GPR survey for boring clearance. The next phase of field work began in August of 1996 and the third phase in May of 1998.

The subcontractors assisting HLA in conducting the RI field program were as follows:

- D.L. Maher, Reading, MA Drilling and monitoring well installation (1995).
- New Hampshire Boring, Londonderry, NH Drilling and monitoring well installation (1996).
- Enpro Environmental Services, Newburyport, MA Test pit excavation.

- ESE/QST, Gainesville, FL and Groundwater Analytical of Woods Hole, MA
 Chemical analysis of environmental samples.
- Martinage Engineering Assoc., Inc., Reading, MA Surveying of site explorations.

All field activities were conducted in accordance with the Fort Devens POP (ABB-ES, 1995b) and USAEC's Geotechnical Guidelines (USAEC, 1987). The following subsections describe the RI field activities performed at AOC 57 in 1995, 1996, and 1998.

5.4.1 Surficial Geophysical Survey

A surficial geophysical survey was performed at Area 2 in September of 1995. Magnetometer and terrain conductivity (EM-31) were performed on a 20-foot grid in an area approximately ten acres in size (Figure 5-8) in an attempt to locate subsurface source(s) of the contamination detected in soils. Geophysical anomalies were investigated with ground penetrating radar (GPR).

A second geophysical survey was performed at Area 3 in August of 1996. The Area 3 survey utilized terrain conductivity (EM-31) and EM-61 on a 10 foot grid in an area approximately 1.5 acres in size (Figure 5-9). The survey was conducted in an attempt to delineate potential subsurface source(s) of the contamination detected in soils and to locate subsurface debris. Data obtained from both of the geophysical surveys were also used to aid in placement of subsequent explorations (e.g., test pits, soil borings, and monitoring wells). Geophysical data and interpretations are provided in Appendix C.

The surficial geophysical survey procedures are outlined in Subsection 4.4.3 of Volume I of the Fort Devens POP (ABB-ES, 1995b).

5.4.2 Surface Water and Sediment Sampling

In order to characterize the impact of AOC 57 Area 2 on Cold Spring Brook, 13 sediment and eight surface water samples were collected from eight locations during the 1995 field investigation (57D-95-03X through 57D-95-10X) (Figures 5-6 and 5-8). Samples were collected from areas of deposition within Cold Spring Brook and the associated wetland. At

five of the locations (57D-95-03X through 57D-95-07X) two sediment samples were collected, one from the top of the sediment layer and one from between 2 and 5 feet below the top of the sediment layer. Sediment samples were collected using either a stainless steel hand spoon, hand auger, or Ekman dredge and were analyzed for petroleum fingerprinting, PAL VOCs, PAL SVOCs, PAL inorganics, PAL pesticides/PCBs, TPHC, TOC, and grain size distribution. In addition, short-term chronic toxicity testing for *Hyallela axteca* and *Chironomus tentans* was performed on whole sediment samples collected at 57D-95-04X through 57D-95-08X and 57D-95-10X.

Surface water samples were collected by direct immersion of the sample container at each of the sampling locations (57W-95-03X through 57W-95-10X). Off-site analysis of the surface water samples consisted of select PAL VOCs, PAL SVOCs, PAL total inorganics, PAL dissolved inorganics, PAL pesticides/PCBs, PAL water quality parameters, and TPHC. Samples for dissolved inorganic analysis were collected using a peristaltic pump and 0.4 micron filter. HLA sampling personnel also measured and recorded water depth, temperature, specific conductivity, pH, turbidity, and dissolved oxygen at the sampling location at time of collection.

In May of 1998 an additional three surface water and sediment samples were collected from Area 2 (57D/W-98-01X, 57D/W-98-02X, and 57D/W-98-03X) (Figure 5-8) and five surface water and sediment samples were collected from Area 3 (57D/W-98-04X, 57D/W-98-05X, 57D/W-98-06X, 57D/W-98-07X, and 57D/W-98-08X) (Figure 5-9). The samples were collected in order to help define the downgradient distribution of contaminants, assess the potential for contaminants discharging to the wetland and floodplain, and to provide data to support the human health and ecological risk assessments. Locations were selected based upon regulatory input during the site walkover and using field analytical data obtained from soil sampling. An effort was made to place sediment samples downgradient of areas with the highest levels of soil contamination.

Sediment samples were collected with a stainless steel hand spoon and screened for TPHC at an on-site laboratory. All sediment samples collected in 1998 were also submitted for off-site analysis for PAL VOCs, PAL SVOCs, select PAL inorganics, PAL pesticides/PCBs, TPHC, and EPH/VPH.

Surface water samples were collected by direct immersion of the sample container. On-site screening for TPHC was performed on all surface water samples. Off-site analysis

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consisted of PAL VOCs, PAL SVOCs, select PAL inorganics, select PAL dissolved inorganics, PAL pesticides/PCBs, and EPH/VPH. Samples for dissolved inorganic analysis were collected using a peristaltic pump and 0.4 micron filter.

5.4.3 Test Pitting

In September of 1995, 23 test pits were installed at Area 2 (57E-95-01X through 57E-95-20X and 57E-95-25X through 57E-95-27X) (Figure 5-8) and four test pits were installed at Area 3 (57E-95-21X through 57E-95-24X) (Figure 5-9). Four additional test pits (57E-96-28X through 57E-96-31X) were installed at Area 3 in August of 1996. Track and tire mounted backhoes were used to excavate the test pits which ranged in depth from 5 to 13 ft. Between three and eight soil samples were collected from each test pit for field analytical screening. Samples collected in 1995 were field analyzed for select chlorinated VOCs, Samples collected in 1996 were field analyzed for select TPHC, and GRO/DRO. chlorinated VOCs and TPHC. Based upon 1995 field analytical results, twenty test pit soil samples were selected for off-site analysis. A confirmatory off-site analytical sample was collected from each of the four test pits installed in the fall of 1996. Off-site analysis for test pit soil samples consisted of petroleum fingerprinting, select PAL VOCs, PAL SVOCs, PAL inorganics, PAL pesticides/PCBs, TPHC, and grain size. During the test pitting, an HLA geologist described activities and observations in test pit logs that are presented in Appendix A. Test pit sampling and geologic data are summarized in Table 5-7.

5.4.4 TerraProbeSM Soil and Groundwater Sampling

Twenty TerraProbeSM points were completed at Area 3, 57R-95-01X through 57R-95-06X in 1995 and 57R-96-07X through 57R-96-20X in 1996 (Figure 5-9). Soil and groundwater samples were collected from the TerraProbeSM points to further define the vertical and horizontal distribution of the soil and groundwater contamination detected in test pit 57E-95-24X and monitoring well 57M-95-03X (Figure 5-9). Three soil samples were collected at each point from depths ranging between 0 and 12 feet, except 57R-95-06X where only one soil sample was collected. Soil samples were analyzed in the field for BTEX, select chlorinated VOCs, and TPHC. Analysis of field chromatograms of samples collected at the beginning of the 1996 investigation indicated that soil and groundwater samples may contain dichlorobenzene and naphthalene. As a result the field GC was calibrated for these compounds and select TerraProbeSM locations resampled. TerraProbeSM locations were based upon geophysical survey results and contaminant distribution as determined by field

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analytical data.

Groundwater samples were collected from 19 of the 20 TerraProbeSM points at depths ranging between 10 and 14 feet bgs and analyzed for BTEX and select chlorinated VOCs. Groundwater was sampled with a peristaltic pump from inside the probe rods. Prior to sampling, the borings were purged using the peristaltic pump. Upon recharge or the removal of two boring volumes a groundwater sample was collected. Sampling procedures are presented in Subsection 4.5.1.3 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Analytical sample results are discussed in detail in Section 7.0 of this report.

5.4.5 Soil Borings and Soil Sampling

A total of 12 soil borings and 15 monitoring well borings were installed during the RI. Soil borings 57B-95-01X through 57B-95-06X and monitoring well borings 57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-95-08B were installed at Area 2 in September and October of 1995 (Figure 5-8). Soil borings 57B-96-07X through 57B-95-12X and monitoring well borings 57M-95-03X and 57M-96-09X through 57M-96-13X were installed at Area 3 in August of 1996 (Figure 5-9).

The monitoring well borings 57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-95-08B were drilled with 6¹/₄-inch inside diameter (ID) hollow stem augers (HSAs). The remainder of the borings were installed with 4¹/₄-inch ID HSAs.

Borings 57M-95-01X, 57M-95-03X, 57M-95-07X, and 57M-95-08B were sampled continuously with 3-inch outside diameter (OD) split spoons using the standard penetration test technique to characterize subsurface stratigraphy. The remainder of the borings were sampled at approximately 5-foot intervals except for 57M-96-12X which was intended to be a monitoring well boring but abandoned after 5-feet of drilling. In addition, only one soil sample was collected from monitoring well borings 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X. Refer to Table 5-8 for reference sample and off-site analytical sample intervals. The soil samples collected from each boring were used for soil classification, field analytical samples and/or off-site laboratory analysis. Soil samples were analyzed in the field for BTEX, select chlorinated VOCs, and TPHC and at the off-site laboratory for petroleum fingerprinting, PAL VOCs, PAL SVOCs, PAL inorganics, PAL

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pesticides/PCBs, TPHC and grain size distribution. Groundwater samples were collected for field analysis by GC from the monitoring well borings 57M-95-01X, 57M-95-02X, 57M-95-03X, 57M-95-06X, 57M-95-07X, 57M-95-08A, 57M-95-08B, 57M-96-09X, 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X. These samples were collected to better define the horizontal distribution of site contaminants for optimum downgradient and crossgradient monitoring well location. Soil boring and sampling procedures are presented in Subsection 4.5.1.3 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Soil boring logs are presented in Appendix A and summarized in Table 5-8. Analytical sample results are discussed in Section 7.0 of this report.

In May of 1998 additional surficial and subsurface soil sampling was performed to better define downgradient contaminant distributions at Areas 2 and 3. Two soil samples, one at the ground surface and one at the water table, were collected from 10 locations at Area 2 (57S-98-01X through 57S-98-10X) (Figure 5-8) and from six locations at Area 3 (57S-98-11X through 57S-98-16X) (Figure 5-9). Samples were collected using a stainless steel hand spoon and stainless steel hand auger. All samples were screened at the on-site laboratory for TPHC. Ten samples from Area 2 and three samples from Area 3 were selected for offsite analysis based upon field observations and the results of the on-site TPHC analysis. Area 2 samples selected for off-site analysis included; 57S-98-01X at 1-foot bgs, 57S-98-02X at ground surface, 57S-98-03X at 2 feet bgs, 57S-98-04X at 1-foot bgs, 57S-98-05X at 3 feet bgs, 57S-98-06X at 1-foot bgs, 57S-98-07X at ground surface and 1-foot bgs, 57S-98-08X at ground surface, and 57S-98-09X at ground surface. Area 3 samples chosen for off-site analysis included; 57S-98-13X at 1-foot bgs, 57S-98-14X at 1-foot bgs, and 57S-98-15X at 3 feet bgs. Off-site analysis of the 1998 soil samples consisted of PAL VOCs, PAL SVOCs, select PAL metals, PAL pesticides/PCBs, TPHC, and EPH/VPH. Sampling procedures are presented in Subsections 4.5.1 and 4.5.1.1 of the Fort Devens POP (ABB-ES, 1995b). Results of the field and off-site analyses are discussed in Section 7.0 of this report.

5.4.6 Monitoring Well/Piezometer Installation

Based on the field analytical results of the test pitting and soil boring programs nine monitoring wells and two piezometers were installed at Area 2 in 1995. In 1998 an additional water table piezometer, 57P-98-02X, was installed (Figure 5-8). All of the monitoring wells were water table wells with the exception of the deeper overburden wells 57M-95-04B and 57M-95-08B. A total of six monitoring wells were installed at Area 3 in

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1996; 57M-95-03X in 1995 and 57M-96-09X through 57M-96-13X in 1996. In 1998 two piezometers were installed at Area 3, 57P-98-03X and 57P-98-04X (Figure 5-9). The piezometers were screened 2 feet below the water table. All of the monitoring wells at Area 3 were water table wells.

Monitoring well construction was completed in accordance with USAEC requirements and Subsection 4.4.6.4 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Monitoring well construction diagrams are provided in Appendix B and a summary of each monitoring well installation is presented in Table 5-9.

5.4.7 Monitoring Well Development

Each of the newly installed RI monitoring wells were developed using the pump and surge method, to remove any water added to the boring during drilling and/or well installation, and to remove sediment from the monitoring well screen prior to groundwater sampling and aquifer testing. Dedicated equipment was used to minimize the possibility of cross contamination occurring between wells and water was not added to the wells during development. The procedures for well development are presented in Subsection 4.4.6.5 of Volume I of the Fort Devens POP (ABB-ES, 1995b).

Monitoring well development is documented on Well Development Field Data Records presented in Appendix G.

5.4.8 Groundwater Sampling

Two rounds of groundwater samples were collected from the nine new and two existing monitoring wells at Area 2 and 57M-95-03X at Area 3. Round 1 samples were collected in October and November of 1995 and Round two samples were collected in February of 1996. The groundwater samples for these two rounds were submitted for off-site laboratory analysis consisting of PAL VOCs, SVOCs, inorganics (both filtered and unfiltered), water quality parameters, TPHC, and TSS. Groundwater sampling procedures are presented in Subsection 4.5.2.2 of Volume I of the Fort Devens POP (ABB-ES, 1995b). One round of groundwater sampling, designated Round 3, was performed at Area 3. Area 3 monitoring wells were sampled in September and October of 1996 following USEPA Region I low-flow sampling protocols as described in "Low Flow (minimum stress) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells:

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SOP # GW 0001" (USEPA, 1996). An additional round of groundwater samples was collected in 1998 from the Area 2 piezometer 57P-98-02X, the Area 3 piezometers 57P-98-03X and 57P-98-04X, and the monitoring well 57M-96-11X. The groundwater samples were screened for TPHC at the on-site laboratory and submitted for off-site analysis for PAL VOCs, PAL SVOCs, dissolved select PAL metals (As, Se, Sb, Ba, Cu, Pb, Mn, and Zn), total select PAL metals, PAL pesticides/PCBs, and EPH/VPH. These samples were collected to better define the distribution of downgradient contamination. Field data records are presented in Appendix H, and off-site laboratory analytical results are discussed in detail in Section 7.0 of this report.

5.4.9 In-Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity tests were performed on all of the monitoring wells installed during the RI to obtain estimates of hydraulic conductivity. Appendix F presents data and analysis of the hydraulic conductivity testing. All tests were performed by rising head methodology. The rate of water level recovery back to static conditions within the well casing or screened interval was monitored using a pressure transducer and data logger. The depression of the water level within the well (for rising head tests) was accomplished with a solid, cylindrical PVC slug using the techniques discussed in Subsection 4.8.2 of Volume I of the Fort Devens POP (ABB-ES, 1995b).

The data from all in-situ hydraulic conductivity tests were analyzed using the method of Bouwer and Rice (1976) with the Aqtesolv computer program. In addition, data were analyzed by the Hvorslev (1951) method. Discussion of the results of in-situ hydraulic conductivity testing are presented in Section 6.0 of this RI report. Hydraulic conductivity data and analyses are provided in Appendix F.

5.4.10 Equipment Decontamination

Several different sampling and analytical procedures were used during the AOC 57 RI field programs, which led to a variety of decontamination procedures. Decontamination procedures were conducted in conformance with Subsection 4.3 in the Fort Devens POP (ABB-ES, 1995b). To document the effectiveness of decontamination procedures, periodic equipment rinsate blanks were collected and submitted for chemical analyses. Analytical results for the rinsate blanks are presented in Appendix D.

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5.4.11 Investigation-Derived Waste

During the field programs at AOC 57 a variety of investigation-derived waste (IDW) was produced, including purge water, soil cuttings, well development water, decontamination fluids, and personnel protective equipment. The collection, handling, and disposal of IDW was conducted in conformance with Subsection 4.10 of the Fort Devens POP (ABB-ES, 1995b).

5.4.12 Location and Elevation Survey

Upon completion of the 1995 and 1996 RI field programs at AOC 57, a location and elevation survey was conducted to accurately locate the explorations, including new and existing monitoring wells, piezometers, soil borings, test pits, surface water/sediment sampling points, and TerraProbeSM points. A topographic survey was also conducted at Areas 2 and 3 of AOC 57 to better define the topographic features at the site.

The surveys were conducted by Martinage Engineering, Inc. of Reading, MA. Horizontal control was established with a Leitz Sokkia II Total Station Vernier reading to one second accuracy. Vertical control was established using a Topcon Auto Level. Vertical locations were measured to within 0.01 feet and the horizontal control was measured as state planer coordinates to the nearest 0.1 feet.

Monitoring wells and piezometers were surveyed for horizontal control and vertical control of the ground surface, top of the protective casing, and the top of the PVC well riser. Soil borings, test pits, surface water/sediment points, and TerraProbeSM points were surveyed for horizontal control and vertical control of the ground surface. Procedures followed during the survey task are outlined in Subsection 4.9 of Volume I of the Fort Devens POP (ABB-ES, 1995b). Appendix I presents a summary of the survey data.

Following the 1998 field program all explorations were horizontally located using a Trimble Pro-SR global positioning system. Piezometers were vertically surveyed by HLA personnel to within 0.01 feet.

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SECTION 5

5.5 1999 AREA 3 CONTAMINATED SOIL REMOVAL

A contaminated soil removal was performed at AOC 57 Area 3 in the spring of 1999. Data collected during the RI showed that a historic garage waste disposal site approximately 40 feet square by five feet in depth was acting as a source of soil and groundwater contamination. Advective transport appears to have aided in the southerly migration of soil contamination. Removal activities were conducted in accordance with the Action Memorandum for AOC 57, Area 3 (HLA, 1999).

Soil excavation was performed with an extended-reach, tracked excavator. Prior to excavation a soil berm was constructed and a silt fence was erected on the southern side of the excavation to prevent migration of contaminated soils or siltation of the Cold Spring Brook wetland. The source area removal was conducted in phases based on results of confirmatory samples collected from the excavation floor and sidewalls. Confirmatory samples were analyzed at an off-site laboratory for pesticides/PCBs and EPH/VPH. In addition, while soils were being excavated, samples were collected for PID headspace analysis to aid in directing the excavation. The extent of the excavation and location of confirmatory samples are provided in Figure 5-9.

PHASE I

The initial soil removal action was completed between March 22 and March 25, 1999. Existing landmarks including monitoring wells and historic sample locations were used as reference points to identify the boundaries of the excavation. The excavation began at the southern end of the source area (near soil boring 57B-96-07X) and moved north. The excavation reached a depth of approximately 5 feet in the southern portion and 10 feet in the north. Phase I of the source area removal action yielded approximately 1400 cubic yards of contaminated soil and debris. A total of ten confirmatory samples, eight sidewall (EX57W01X through EX57W08X) and two floor samples (EX57F01X and EX57F02X), were collected for off-site analysis.

Results of confirmatory sampling are discussed in detail in Section 7.0.

PHASE II

Phase I confirmatory sampling indicated that residual PCB contamination was present in

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two of the samples (EX57W03X and EX57F01X) at levels in excess of MCP S-2/GW-3 standards but below the risk based goal for subsurface soils of 4 μ g/g. The PCB detections were located at the southern extent of the excavation. In response to these results a second phase of the soil removal action was conducted on April 15 and 16, 1999. The Phase II excavation was started approximately 50 feet south of the existing excavation in this area was approximately 12 feet, the same as the southern tongue of the previous excavation. In addition, the southwestern wall of the previous excavation was expanded approximately three feet to the west. The phase II excavation was approximately three feet deep in the southern end and approximately 5 feet deep at the northern end where it joined the Phase I excavation.

A total of six confirmatory samples were collected from within the excavation including five wall samples (EX57W09X through EX57W13X) and one floor sample (EX57F03X). A total of 320 cubic yards of material was removed during this phase of the soil removal action.

The results of the Phase II confirmatory samples indicated that elevated concentrations of PCBs and EPH were present on the southern wall of the excavation. Therefore, on May 26, 1999 PCB immuno-assays were used to delineate the area of residual PCB contamination. Samples were collected from eleven location using a hand auger. The sample locations were within two to six feet of the excavation and the samples were collected from one to three feet bgs. Some of the locations were sampled at multiple depths.

PHASE III

Based upon the results of the PCB screening and the Phase II confirmatory sampling, additional excavation was performed in the area extending laterally two feet around the southern tongue of the excavation. No additional material was removed from the bottom of the excavation in this area. Four confirmatory samples were collected from the sidewalls. An additional 140 cubic yards of soil was removed during the Phase II excavation.

In total, 1860 cubic yards of soil was removed during the Area 3 soil removal. The contaminated soil was stored adjacent to Barnum Road. The soil was placed on poly-

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sheeting, and covered with reinforced poly-sheeting. Straw bales were placed around the covered soil pile to prevent runoff to the surrounding area.

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SECTION 6

6.0 SITE HYDROLOGY, GEOLOGY AND GROUNDWATER CHARACTERIZATION

6.1 SITE HYDROLOGY

AOC 57 is located in the eastern portion of the former Main Post south of Barnum Road. The most significant hydrological feature is Cold Spring Brook, which originates in the central part of the former Main Post at Devens. Its headwaters are formed by runoff and groundwater discharge in the vicinity of the former Ammunition Storage Point and Cold Spring Brook landfill. Further downstream, it flows north through woodlands and wetlands and passes beneath the B&M Railroad right-of-way at Barnum Road. From there the brook is fed by runoff and groundwater discharge from the former Army property south of Barnum Road. It is at this point that the brook passes to the south of AOC 57 (Figures 5-1 and 5-2). The brook continues to flow northeast off Devens property where it ultimately discharges to Grove Pond. The portion of the brook that is located south and southeast of Barnum Road has been designated Lower Cold Spring Brook and was the subject of the Lower Cold Spring Brook Site Investigation (ABB-ES, 1995c).

Lower Cold Spring Brook is characterized by a four to six feet wide meandering stream channel surrounded by 20 to 60 feet of scrub and emergent cattail marsh. Downstream from AOC 57 Area 2 the stream channel becomes poorly defined and dendritic flow paths become more predominant. The 1977 earthen containment dike located immediately south of AOC 57 Area 2 is not believed to have caused ponding of the brook. Observations of flow through the southern portion of the dike indicate that flow is not significantly impeded. In addition, the emergent marshes are of equal width immediately upstream and downstream of the containment dike instead of just upstream as would be expected if ponding were occurring.

Precipitation runoff near Area 1 is primarily controlled by the storm drain No. 6 outfall. The outfall flows into an eroded drainage ditch which becomes dendritic and poorly defined before ultimately discharging to Cold Spring Brook.

Precipitation runoff in the vicinity of AOC 57 Area 2 is controlled primarily by topography and the drainage ditch that runs roughly north to south through Area 2 (Figure 6-1) eventually discharging to the Cold Spring Brook wetlands.

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Area 3 precipitation runoff is primarily northwest to southeast as dictated by the topography. Runoff occurs in eroded channels that are 0.5 to 1 foot deep. Runoff discharges and infiltrates in the Cold Spring Brook flood plain and upper portion of the wetlands. There is no direct surface runoff from Area 3 to the Cold Spring Brook stream channel.

6.2 SITE GEOLOGY

This subsection presents descriptions of the geologic formations encountered at AOC 57 Areas 2 and 3. Figures 6-1 and 6-2 show the orientations of the geologic cross sections. Figures 6-3 through 6-6 present geologic cross sections A-A' through D-D', respectively. Bedrock was not encountered at AOC 57.

6.2.1 Overburden Soils

Surficial and subsurface soils at AOC 57 Areas 2 and 3 are classified by the SCS as the Hinckley-Merrimac (Freetown)-Windsor Association (see Figure 2-3). The soil is. described as being deep; excessively to moderately well drained; nearly level to very steep (see Subsection 2.2.5). Boring logs are presented in Appendix A and results of grain size analysis are provided in Appendix J.

6.2.1.1 Area 2 Soils. Data from soil borings and test pits indicate that soils at Area 2 are comprised of reworked gravelly sands and silty sands overlying a discontinuous black ashy silt layer which in turn overlies native, poorly to well graded sand and silty sand.

The surficial gravelly sands and silty sands are predominately located on the flat northern portion of the site between the treeline and Barnum Road. These soils are comprised of dark brown to tan well graded to poorly graded fine to medium sand. Gravel and silt contents vary between 5 and 30 percent with generally higher silt fractions near the treeline and floodplain and increased gravel content to the north toward Barnum Road. The surficial soils vary in thickness from 0.5 to 2.0 feet. A layer of black ashy silt, sand, and gravel discontinuously underlies the surficial soil. The ashy layer was observed to be 2 to 6-inches thick in the relatively flat area between Barnum Road and the treeline. The ashy layer increases to a maximum observed thickness of 3 feet at the break in slope just inside the treeline (57E-95-06X). This layer was not observed in test pits excavated within the

floodplain; however, gravel sized pieces of charcoal were found in test pits just over the break in slope (57E-95-20X). It is assumed that these two soil layers represent fill from two different periods. The ash layer may be due to disposal of spent coal from the former power plant located on the north side of Barnum Road and/or it may have served as grade material for a motor pool to service Building 3713.

The surficial layer of the Cold Spring Brook 100 year floodplain, starting at approximately the 228 foot topographic contour, is comprised of fluvial deposits of silty sand and silt ranging in observed thickness of 1 to 4 feet. Laterally discontinuous deposits of black silty organic material from 1 inch to 2 feet in thickness underlie the surficial material.

Native subsurface soils encountered at the site are comprised of yellowish brown to gray, fine to medium, loose to medium dense, poorly to well graded sand and silty sand. Rust colored staining was apparent in soil samples from several explorations (57M-95-05X, 57M-95-07X, 57M-95-08B, and 57B-95-05X).

6.2.1.2 Area 3 Soils. The northern portion of Area 3 from the motor pool fence to the break in slope inside the treeline (located between the 230 and 235 foot topographic contours) is comprised of fill material ranging in observed thickness from 1 to 6 feet bgs (Figures 6-5 and 6-6). The fill is comprised of silty sand and gravel which is poorly to well graded. Assorted debris was observed in all of the test pits excavated at Area 3. It appears that Area 3 was used as a disposal area for vehicle maintenance debris presumably generated by the Barnum Road motor pools. Surficial debris (e.g., concrete, barbed wire, cans) was observed within the wooded floodplain. Native soils at the site are comprised of fine to medium, tan to gray, poorly graded sand near the northern portion of the site (57E-95-21X through 57E-96-31X). Floodplain deposits consist of loose to medium dense, gray fine silty sands as observed in monitoring well borings 57M-96-10X through 57M-96-13X.

A dark brown to black sandy organic layer, presumably an accumulation of organic matter, eluviated from the upper horizons overlies the native gray sand. The organic layer was relatively continuous across the undisturbed portions of the site, ranging in depth from three to four feet bgs in the northern portion of the site to 1 foot bgs in the southern flood plain area.

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6.2.2 Bedrock Geology

Bedrock was not encountered in any of the borings at either Area 2 or 3. The bedrock in the vicinity of AOC 57 has been classified as the Berwick Formation. The formation is described as thin- to thick-bedded metamorphosed calcareous metasiltstone, biotitic metasiltstone, and fine-grained metasandstone, interbedded with quartz-muscovite-garnet schist and feldspathic quartzite (Zen, 1983; Robinson and Goldsmith, 1991). Depth to bedrock is assumed to be approximately 100 feet bgs. This is based on the known depth to bedrock of 137.5 feet bgs at the Grove Pond well triplet located in the Massachusetts National Guard property approximately 2,000 feet to the north-northeast.

6.2.3 Site Geology Interpretation Summary

Geology at both Area 2 and Area 3 is comprised of fill materials overlying native sandy soils. The fill materials above the floodplain (228-foot topographic contour) at Area 2 are comprised of reworked gravelly sand and silty sand 0.5 to 2 feet in thickness overlying a 2 to 6-inch thick discontinuous ash and coal layer. The fill layers reach a maximum observed thickness of 3 feet at the break in slope above the floodplain.

Floodplain deposits consist of 1 to 4 feet of silty sand and silt overlying black organic soils which are 1-inch to 1-foot thick and laterally discontinuous.

Fill materials at Area 3 are comprised primarily of reworked sand and silty sand, garage waste, and construction debris. The fill layer reaches a maximum observed thickness of 6 feet at test pit 57E-95-24X. Surficial debris was observed within the floodplain south of the 225 foot topographic contour. The vegetation of the floodplain area is scrub oak, maple and brush while 150 feet to the east the vegetation turns to mature pine. The change in vegetation is also coincident with the eastern extent of the surficial debris. Subsurface soil was observed to be comprised of fine to medium, tan to gray, poorly graded sand near the northern portion of the site (57E-95-21X through 57E-96-31X). Floodplain deposits consist of loose to medium dense, gray, fine silty sands as observed in monitoring well borings 57M-96-10X through 57M-96-13X. Native soils area overlain by a sandy organic layer approximately 1-foot thick.

6.3 HYDROGEOLOGY

This subsection presents data and interpretations of hydrogeologic conditions at AOC 57 Areas 2 and 3. Groundwater levels used in this subsection are provided in Table 6-1 and interpretive water table elevation contours are presented on Figures 6-7 through 6-10. Water level elevations at Area 2 were measured on December 7, 1995, March 26, 1996, July 23, 1996, January 15, 1997, June 2, 1997, and September 23, 1998. Water level elevations at Area 3 were measured on January 15, 1997, June 2, 1998.

6.3.1 Area 2 Hydrogeology

As a result of the type of contaminants (primarily fuel related compounds) identified in groundwater at AOC 57 Area 2, the majority of the monitoring wells have been installed as water table wells (i.e., their screened interval, including sandpack, spans the water table)(see Figures 6-3, 6-4 and Table 5-8). A total of 11 monitoring wells, G3M-92-02X, G3M-92-07X, 57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-95-08B and three piezometers 57P-95-01A, 57P-95-01B, and 57P-98-02X were installed in overburden soils. Of these, all are water table monitoring wells except for 57M-95-04B and 57M-95-08B which are screened from 18 to 28 feet below ground surface and approximately 14 feet below the water table and the piezometer 57P-95-01B which was screened from 10 to 15 feet bgs, approximately eight feet below the water table.

The water table occurs in the overburden across AOC 57 Area 2 (Figure 6-3 and 6-4). Figures 6-7 and 6-8 present interpreted water table elevation contours for Area 2 based on the January 15, 1997 and September 23, 1998 data sets, respectively. Groundwater flow is predominately north-northwest to south-southeast toward Cold Spring Brook. These flow directions are in agreement with the basewide overburden groundwater flow model (Figures 2-6 and 2-7) (ETA, 1995). Local variations in the flow scheme occur in the floodplain from the vicinity of monitoring well 57M-95-05X to the area of flooded emergent marsh west of the containment dike (Figure 6-7 and 6-8). The marsh is a local groundwater discharge area and the effects of this are seen as depressed water levels in the adjacent floodplain and a convergence of flowpaths towards the marsh. The depression adjacent to the marsh, and therefore the convergence of flowpaths, is more pronounced during low water levels. The depressed water levels also indicate that the containment dike is not causing ponding of

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Cold Spring Brook.

A review of historical groundwater level data indicates that the brook and associated wetlands act as a mediating influence on water levels. A comparison of data from March of 1996 and January of 1997 shows increases in water levels of over 1 foot near Barnum Road (225.5 to 226.71 feet at G3M-92-02X and 225.33 feet to 226.32 feet at 57M-95-01X) while monitoring wells and piezometers adjacent to the wetland show increases on the order of 0.1 feet (220.65 to 220.71 at 57P-95-01A and 221.11 to 221.25 at 57M-95-04A) for the same time period.

Horizontal hydraulic gradients were calculated from each set of water level measurements. Gradients were calculated using multiple wells that, as much as possible, share a common flow path. In general, horizontal hydraulic gradients are flatter in the northern portion of the site above the break in slope and more steep near the break in slope and floodplain. Multiple wells were selected with respect to this so as to provide representative gradients. Calculations are provided in Appendix F. The geometric mean of horizontal hydraulic gradients calculated for all data sets range between 0.0095 ft/ft (December 7, 1995) and 0.013 ft/ft (July 23, 1996).

Vertical hydraulic gradients were calculated between the piezometer pair 57P-95-01A/57P-95-01B and the monitoring well pairs 57M-95-04A/57M-95-04B and 57M-95-08A/57M-95-08B (Figure 6-7 and 6-8) for each set of water level measurements. The piezometer pair yielded upward gradients ranging between 0.028 and 0.039 ft/ft. The 57M-95-04A/57M-95-04B well pair showed relatively no vertical gradient with calculated values ranging between 0.002 ft/ft upward and 0.0006 ft/ft downward. Downward vertical gradients between 0.001 and 0.019 ft/ft were measured at 57M-95-08A/57M-95-08B. The decrease in magnitude of upward vertical gradients between the piezometer pair 57P-95-01A/57P-95-01B and the monitoring well pair 57M-95-04A/57M-95-04B as well as the change to a small downward vertical gradient at 57M-95-08A/57M-95-08B is in direct correlation with their distances from the brook and wetland.

In-situ Hydraulic Conductivity Results. In-situ hydraulic conductivity test results presented in Table 6-2 indicate that estimates of hydraulic conductivity as calculated by the Bouwer and Rice method range between 1.2×10^{-1} cm/sec (2.4×10^{-1} ft/min) and 4.2×10^{-4} cm/sec (8.3×10^{-4} ft/min) at 57M-95-01X and 57M-95-08A, respectively. The geometric mean of the monitoring wells hydraulic conductivities was calculated as 1.7 x

 10^{-2} cm/sec (3.3 x 10^{-2} ft/min). Estimates of hydraulic conductivity as calculated by the method of Hvorslev range between 1.3 x 10^{-2} cm/sec (2.3 x 10^{-2} ft/min) at 57M-95-01X and 4.3 x 10^{-5} cm/sec (8.4 x 10^{-5} ft/min) at 57M-95-08A. The geometric mean of the hydraulic conductivities as calculated by the Hvorslev method is 6.0 x 10^{-4} cm/sec (1.2 x 10^{-3} ft/min). The hydraulic conductivity test results are presented in Appendix F.

Groundwater Velocity Analyses. Flow velocities were estimated for AOC 57 Area 2 using maximum, minimum, and mean horizontal hydraulic gradients and hydraulic conductivities as determined by the Bouwer and Rice method (calculations are provided in Appendix F). An overburden porosity of 30 percent was assumed for the predominately sandy soils. The maximum groundwater flow velocity was estimated at 14 feet per day (ft/day) and the minimum flow velocity was calculated as 0.038 ft/day. A flow velocity of 1.56 ft/day was calculated using the geometric mean of observed hydraulic conductivity and horizontal gradients.

6.3.2 Area 3 Hydrogeology

A total of six monitoring wells, 57M-95-03X, 57M-96-09X, 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X and two piezometers, 57P-98-03X and 57P-98-04X were installed in overburden soils. All of the groundwater monitoring points at Area 3 have been installed as water table wells (i.e., their screened interval, including sandpack, spans the water table) with the exception of the piezometers 57P-98-03X and 57P-98-04X which are screened 2 feet below the water table (see Figure 6-6 and Table 5-8).

The water table occurs in the unconsolidated overburden across AOC 57 Area 3 (Figure 6-5 and 6-6). Figures 6-9 and 6-10 present interpreted water table elevation contours for Area 3 based on the January 15, 1997 and September 23, 1998 data sets. Groundwater flow is predominately from the north-northwest to the south-southeast toward Cold Spring Brook. These flow directions are in agreement with the basewide overburden groundwater flow model (Figures 2-6 and 2-7)(ETA, 1995).

Horizontal hydraulic gradients were calculated from the January 15, 1997, June 2, 1997, and September 23, 1998 water level measurements. Gradients were calculated using multiple wells that, as much as possible, share a common flow path. In general, horizontal hydraulic gradients are flatter on the northern portion of the site above the break in slope and steeper near the break in slope and floodplain. Multiple wells were selected with respect to this so

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as to provide representative gradients. Calculations are provided in Appendix F. The geometric mean of calculated horizontal hydraulic gradients ranged between 0.022 ft/ft on January 15, 1997 and 0.015 ft/ft on September 23, 1998.

Deeper overburden wells were not installed at AOC 57 Area 3, but data from Area 2 suggests that groundwater discharges to Cold Spring Brook and its associated wetlands. The presence of surface water in depressions in the Area 3 floodplain further suggests that groundwater discharge is occurring.

In-situ Hydraulic Conductivity Results. In-situ hydraulic conductivity test results from Area 3 presented in Table 6-2 indicate that estimates of hydraulic conductivity as calculated by the Bouwer and Rice method range between 5.6×10^{-3} cm/sec $(1.1 \times 10^{-2} \text{ ft/min})$ and 6.9 $\times 10^{-4}$ cm/sec $(1.4 \times 10^{-4} \text{ ft/min})$ at 57M-95-03X and 57M-96-10X, respectively. Hydraulic conductivity estimates calculated by the Hvorslev method range between 5.3×10^{-4} cm/sec $(1.0 \times 10^{-3} \text{ ft/min})$ at 57M-95-03X and 2.2 $\times 10^{-5}$ cm/sec $(4.4 \times 10^{-4} \text{ ft/min})$ at 57M-96-10X. The geometric mean of the monitoring wells hydraulic conductivities was calculated as 1.8 $\times 10^{-3}$ cm/sec $(3.5 \times 10^{-3} \text{ ft/min})$ by the Bouwer and Rice Method and 6.0×10^{-4} cm/sec $(1.2 \times 10^{-3} \text{ ft/min})$ by the Hvorslev method. In general, hydraulic conductivities are greater in the northern portion of the site and decrease as the soils grade finer in the floodplain. The hydraulic conductivity test results are presented in Appendix F.

Groundwater Velocity Analyses. Flow velocities were estimated for AOC 57 Area 3 using maximum, minimum, and mean horizontal hydraulic gradients and hydraulic conductivities as determined by the Bouwer and Rice method (calculations are provided in Appendix F). An overburden porosity of 30 percent was assumed for the predominately sandy soils. The maximum groundwater flow velocity was estimated at 1.2 ft/day. A minimum flow velocity of 0.14 ft/day was calculated for the water table. A flow velocity of 0.34 ft/day was calculated using the geometric mean of observed hydraulic conductivity and horizontal gradients.

6.3.3 Site Hydrogeology Interpretation Summary

Groundwater at AOC 57 Areas 2 and 3 occurs in the overburden and bedrock aquifer. Bedrock aquifer characteristics were not monitored at AOC 57. Flow directions are predominately from the north-northwest to the south-southeast with local variations occurring as groundwater discharges to Cold Spring Brook. Upward vertical gradients were

observed in the piezometer pair 57P-95-01A/57P-95-01B at Area 2 during each groundwater level measurement round near Cold Spring Brook. Small downward vertical gradients were measured at the monitoring well pair 57M-95-08A / 57M-95-08B which is located at a greater distance from the brook. This same scenario is believed to hold for Area 3. The moderately fast groundwater flow velocities are consistent with the type of soil (sand) observed at this AOC. Water level data at Area 2 indicates that the containment dike is not causing ponding of the water table.

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7.0 NATURE AND DISTRIBUTION OF DETECTED SITE CONTAMINANTS

The following subsections address the nature and distribution of analytes detected in surface water, sediment, soil, and groundwater collected from AOC 57_during_the 1995, 1996, and 1998 RI field efforts. Additional data is also included from the Area 3 source area soil removal completed during the Spring of 1999. Data obtained from the off-site laboratory and from the on-site field analytical laboratory are presented in this section.

During implementation of the RI field programs, field analytical results were used to direct placement of soil borings, test pits, and monitoring wells, and were used to define the vertical and/or horizontal distribution of contaminants. Field analytical results were also used to select samples for off-site laboratory analysis. Samples were collected from contaminated zones to gather information on the nature and concentration of contaminants as well as from clean areas for off-site confirmation. Field analytical data were used to supplement the off-site laboratory analytical data in the assessment of the nature and distribution of detected analytes.

This assessment of site-related contaminants relies upon tables and figures to present the field and off-site laboratory analytical data. The tables contain only detected analytes and concentrations for samples within a given media. The figures aid in assessing areal distribution of site contaminants. The text provides detail, interpretation, and analysis of the tabulated data. A complete report of the field and off-site analytical data is presented in Appendix M.

7.1 APPROACH TO CONTAMINATION ASSESSMENT

Off-site laboratory analytical results and field analytical data are the primary data used to assess impacts at the site from suspected past disposal and storage practices.

A summary of the analytes detected in RI samples analyzed at the off-site laboratory and during on-site field screening are presented in Tables 7-10 through 7-21. A complete data set of field and off-site analytical data, including non-detect results, is presented in Appendix M. Tentatively identified compounds (TICs) reported for off-site laboratory data are discussed in Subsection 7.1.1 and presented in Table 7-1.

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Analytes detected in QC blanks analyzed at the off-site laboratory are presented in Subsection 7.1.2. A blank contamination evaluation was performed with this data to identify probable sampling and off-site laboratory-related contaminants. The contamination assessment included determining uncertainty regarding potential false positive results due to sampling and off-site laboratory contaminants. Data presented in the tables were not qualified or corrected for blank contamination. However, based on the blank contamination assessment performed, a "*" flag has been added to the data when applicable, to indicate probable blank contamination. A detailed review of method blank and field laboratory quality control blank analyses from the RI program is presented in the DQR reports in Appendix D.

An evaluation of analytical data precision and accuracy was conducted using results of field duplicate and MS/MSD analyses. Accuracy of VOC and SVOC results were also evaluated using surrogate recovery data from each sample analysis. The results for some analytes have been identified as estimated based on the field duplicate, surrogate, and/or MS/MSD data. In some cases, possible data biases have been identified. A summary of data usability interpretations is contained in Subsection 7.1.2. Detailed discussions of surrogate, field duplicate, and MS/MSD results are presented in Appendix D.

7.1.1 Tentatively Identified Compounds/Non-Project Analyte List Compounds

During off-site laboratory analysis, non-project analyte list compounds present in VOC and SVOC samples were tentatively identified by comparing the GC/mass spectroscopy (GC/MS) spectra to those contained in the National Bureau of Standards mass spectral library. Once the tentative identification was made based on matching spectra, the appropriate USAEC code name was assigned for that compound.

Reported concentrations of TICs are considered estimated and are not based on calibration standards. If no compound identification was possible, the compound became listed as an unknown with an assigned number. The assigned number which accompanies the prefix "UNK" is determined by the relative retention time to the internal standard. For example, if the relative retention time of the compound compared to 1,4-difluorobenzene is 1.42, the compound would be assigned the number "UNK142" in IRDMIS.
The requirements for making tentative identification of compounds are listed in the Fort Devens POP (ABB-ES, 1995a) as follows:

- 1. Relative intensities of major ions in the reference spectrum (ions > 10 percent of the most abundant ion) should be present in the sample spectrum.
- 2. The relative intensities of the major ions must agree within 20 percent.
- 3. Molecular ions present in the reference spectrum should be present in the sample spectrum.
- 4. Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
- 5. Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting compounds. Data system library reduction programs can sometimes create these discrepancies.
- 6. If in the technical judgment of the mass spectral interpretation specialist, no valid tentative identification can be made, the compound should be reported as unknown.

7.1.1.1 TICs Detected in Samples from AOC 57. VOC and SVOC TICs and unknown compounds were detected in several samples collected from AOC 57 Areas 2 and 3. These compounds are differentiated from target analytes in the USAEC's IRDMIS with an "S" flag in the flagging code field. All TICs associated with samples from AOC 57 collected during the 1995 and 1996 RI investigations and from the RI groundwater sampling events are summarized below and are presented in Table 7-1.

It is important to note that in addition to the GC/MS method used to identify and report the alkanes and aromatics identified as TICs, USEPA Methods 418.1, 9071 and 8015 were used during the off-site analysis of soil and water samples to quantify and classify hydrocarbons within these chemical classes. Field analysis was conducted on many samples during the RI using a modified version of USEPA Method 418.1. The field analysis method was designed to provide data on the distribution of these fuel hydrocarbons. Field analytical

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results were used to direct field exploration programs and provide supporting data for the off-site sample results. The off-site laboratory USEPA Method 418.1 results are the primary data used to make quantitative evaluations of these chemicals as TPHC.

<u>1995 RI TICs</u>. The only TICs detected in surface water samples were hexane, a VOC TIC at 5 μ g/L, and an unknown SVOC at 8 μ g/L.

TICs detected in groundwater, soil and sediment samples collected during the 1995 RI consisted primarily-of-alkenes, alkanes, alkyl-substituted-alkanes, and alkyl-substituted benzenes, toluenes and naphthalenes. TICs detected in soil, groundwater and sediment samples and are shown in Tables 7-1.

The field samples with the highest concentrations and the most frequent detection of these TICs include soil samples EX570200, EX570704, EX571502, EX572404, EX572500 at concentrations ranging from approximately 0.0077 μ g/g to 100 μ g/g, groundwater samples MX5703X1, MX5703X2, and MD5703X2 at concentrations ranging from 4 μ g/L to 200 μ g/L, and sediment sample DD570300 at concentrations ranging from 0.03 μ g/g to 50 μ g/g. The presence of alkanes and alkyl-substituted compounds in these samples may be indicative of gasoline and/or fuel related contamination.

The freon compound 1,1,2-trichloro-1,2,2-trifluoroethane was detected in AOC 57 samples, however, this compound was also detected in the laboratory method blanks indicating that its presence is not site-related.

Other compounds detected in samples collected from AOC 57 include molecular sulfur, and gamma-sitosterol.

Samples also contained unknown VOCs and SVOCs ranging from 0.007 μ g/g to 10,000 μ g/g in soil, 5 μ g/L to 600 μ g/L in groundwater samples, and 0.01 μ g/g to 90 μ g/g in sediment samples.

<u>1996 RI TICs</u>. TICs detected in field samples collected during the 1996 RI consisted primarily of alkenes, alkanes, alkyl-substituted-alkanes, and alkyl-substituted benzenes, toluenes and naphthalenes.

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Alkanes detected include nonane, undecane, decane, dodecane, and tetradecane. Examples of substituted alkane and alkene compounds detected in soil and groundwater samples include: 2,2,6-trimethyloctane; 2,6,10,14-tetramethylpentadecane; 2,6-dimethylundecane; 2,6-dimethyloctane; 3,6-dimethyloctane; 3,7-dimethylnonane; 3-methyldecane; 6-methyldodecane; 6-methyltridecane; 7-trimethyldecane; 3-methylcyclohexene; 1,3,5-trimethylcyclohexane; as well as hexadecanoic and octadecenoic acid.

The alkyl-substituted benzenes, toluenes and naphthalenes detected in soil and groundwater samples were as follows: sec-butylbenzene; 1,2,3,5-tetramethylbenzene; 1,2,4-trimethylbenzene; 1,2,3-trimethylbenzene; dichlorobenzenes; 1-ethyl-3-methylbenzene; and 1-ethy-4-methylbenzene; n-propylbenzene; 4-(1-methylethyl)toluene; 4-ethyltoluene; decahydro-2-methylnaphthalene and 1-methylnapthalene.

The concentration of the TICs listed above ranged from 5 μ g/L to 100 μ g/L in five groundwater samples, and from approximately 1 μ g/g to 60 μ g/g in twelve soil samples. The field samples with the highest concentrations and the most frequent detection of these TICs include groundwater sample MX5703X3 and soil samples EX573006, BX570705, and EX572810. The presence of alkanes and alkyl-substituted compounds may be indicative of gasoline and/or fuel related contamination.

The freon compound 1,1,2-trichloro-1,2,2-trifluoroethane was detected in AOC 57 samples, however, this compound was also detected in the laboratory method blanks indicating that it's presence is not site-related.

Other compounds detected in soil samples collected from AOC 57 include benzo[b]thiophene in soil sample BX571010 at 0.0077 $\mu g/g$.

Samples also contained unknown VOC and SVOC TICs ranging from 0.009 μ g/g to 10,000 μ g/g in soil, and 4 μ g/L to 300 μ g/L in groundwater samples. Specific samples with detections of unknowns include soil samples BX571105, BX571110, BX570800, BX571005, BX571010, BD571110, EX573006, BX570700, BX570705, EX573810 and groundwater samples MX5703X3, MX5709X1, MX5711X1, and MX5713X1.

1998 Supplemental Field Investigation

A subset of samples had non-target compounds reported as tentatively identified

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compounds (TICs) in the VOA and SVOA data. TICs are summarized In Appendix D-4, Table D-11.

The majority of SVOA non-target compounds were reported as unknowns. TICs included alkanes (C16 -C29), β -sitosterol, and alpha-pinene. Sediment and soil samples contained numerous unknowns ranging in total concentration per sample from <5 μ g/g to 171 μ g/g. The β -sitosterol, and alpha-pinene are interpreted to represent natural organics. The alkanes and unknowns may represent fuel related contamination.

No TICs were reported in VOA soils. A number of fuel related hydrocarbons were reported in aqueous samples including light alkanes, alkyl-substituted benzenes, and cyclohexanes which are indicators of possible gasoline contamination.

7.1.2 Potential Laboratory and Sampling Contaminants

An evaluation of results from rinse, trip, and laboratory method blank analyses was conducted to determine possible contaminant contributions originating from non-siterelated sources. Potential sources of contamination include materials used during borehole advancement and monitoring well installation, field sampling procedures, field equipment decontamination, sample shipment, laboratory storage, and laboratory analysis.

Because the majority of off-site analytical data were generated using USAEC methods, USEPA data validation guidelines related to the evaluation of blank contamination were not implemented. The following blank contamination assessment approach for organics was used regarding laboratory method blank and field QC sample blank contamination:

- 1. Non-target VOCs and SVOCs TICs that are common organic laboratory contaminants (USEPA, 1988) are not considered chemicals of concern. These common organic laboratory contaminants identified in this document include:
 - Siloxanes; diethyl ether; 1,1,2-trichloro-1,2,2-trifluoroethane; fluorotrichloromethane; and phthalates at levels less than 100 μ g/L or 4 μ g/g in samples collected during the 1995 Field Investigation and the Round 2 Groundwater sampling event.

- trifluorochloromethane at levels less than $0.1 \mu g/g$ in samples collected during the 1996 Field Investigation.
- Solvent preservatives such as cyclohexane, and related by-products including cyclohexene, cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorohexanol.
- Aldol condensation products of acetone including 4-hydroxy-4-methyl-2pentanone, 4-methyl-2-penten-2-one, and 5-dimethyl-2(5H)-furanone.
- 2. The additional TICs detected in semivolatile organic analysis (SVOA) blanks include heptacosane, nonacosane and dioctyladipate. The VOC TICS detected hexane and ethanol. The investigations during which these TICs were detected are shown in Tables 7-2 and 7-4.
- 3. For organic target compounds, trends in method and field blanks were evaluated. Several target compounds routinely detected have been identified by USEPA as common laboratory contaminants including:
 - phthalates
 - methylene chloride, acetone, toluene, and methyl ethyl ketone (2-butanone) at concentrations comparable to concentrations observed in blanks.
- 4. The pesticides malathion detected in method blanks at 0.188 μ g/L and alpha- and gamma-chlordane in method blanks at concentrations up to 0.01 μ g/g.

Detailed discussions of blank results are presented in Appendix D.

Organic target analytes detected in method blanks and rinse blanks during the 1995 and 1996 field investigations and the 1995 Round 2 Groundwater Sampling Event are summarized in Tables 7-2 and 7-3. VOCs detected in trip blank samples collected during the 1995 Field Investigations and the Round 2 Groundwater Sampling Event are summarized in Table 7-4. Trip blanks analyzed during the 1996 investigation did not have any detections of VOCs reported. Organic compounds detected in samples at similar concentration ranges as those in blanks are identified and discussed qualitatively in the

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contamination assessment, and carried through the risk assessment calculations.

Inorganic elements were not reported in rinse blanks and water method blanks. Inorganic detections in the soil method blanks are not presented because the source of elements is believed to be the blank soil matrix rather than laboratory contamination (see Appendix D, Section 2.0). Inorganic sample data presented in the data tables and risk assessment tables were not revised based on blank contamination results. All inorganic detections were used for risk assessment calculations.

During the RI, samples were analyzed for a variety of water quality parameters to generate data to support the development of alternatives during the FS process. No rinse blank or method blank contamination was reported for the water quality parameters analyzed.

A more detailed discussion of laboratory QC sample results is presented in the DQRs in Appendix D.

1998 Supplemental Field Investigation

The following compounds should be evaluated as potential contaminants when using analytical data from the 1998 Supplemental Field Investigation:

- 1. Based on method blank data evaluations presented in Appendix D4, Section 2.1, low concentrations of bis(2-ethylhexyl)phthalate and manganese in aqueous samples may represent laboratory contamination.
- 2. Based on method blank data evaluations presented in Appendix D4, Section 2.1, low concentrations of TPHC (at approximately 36.5 μ g/g), barium (8.31 μ g/g), manganese (21.2 μ g/g), alpha-chlordane (.0058 .0082 μ g/g), gamma-chlordane (.0092 .013 μ g/g), and the TIC diacetone alcohol in soil samples may represent laboratory contamination.

7.1.3 Analytical Data Accuracy and Precision

Analytical data accuracy and precision was evaluated using MS and field duplicate analyses for the majority of off-site and on-site laboratory analytical methods. Surrogate recoveries were reviewed to evaluate the accuracy of volatile organic analysis (VOA) and SVOA

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measurements. This evaluation was conducted to support the AOC 57 1995 and 1996 RI field programs. Detailed discussions and presentation of these results are included in the DQR for the 1995, 1996, and 1998 investigations shown in Appendix D.

1999 Source Area 3 Removal Action

Samples collected during the Source Area 3 removal action included hydrocarbon analyses using Massachusetts VPH/EPH methods (MADEP, 1998), and pesticide and PCB analyses using USEPA SW846 methods (USEPA, 1996). A detailed discussion of data quality evaluations for samples collected during removal is presented in Appendix D-5.

Matrix spike, field duplicate, and surrogate results for the majority of the and target analytes evaluated during the RI indicate the accuracy and precision of results were within project goals outlined in the Fort Devens POP (ABB-ES, 1995a) and USEPA control limits (USEPA, 1988; USEPA, 1989). Trends were reviewed for each set of QC sample data from each field event to determine if qualification of the accuracy of results was needed. The results for some analytes in AOC 57 samples have been identified as invalid or as estimated values with potential biases noted.

The following items summarize data usability considerations for the RI program data collected in 1995 through 1998:

7.1.3.1 Off-Site Laboratory Data.

<u>AOC 57 1995 RI</u>

- 1. Based on spike recovery data discussed in Appendix D, Subsection D.3.1.1, positive detections of selenium in soil are considered estimated with no particular low or high bias.
- 2. Results for MS and MSDs, discussed in Subsection D.3.1.1 of Appendix D, indicate lead results for soil analyzed by GFAA are estimated, and results may be biased low.

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- 3. High frequency of MS/MSD recoveries above the upper control limits indicate that there may be some matrix interference for arsenic (Appendix D, Subsection D.3.1.1). Positive results reported for arsenic in soil samples should be considered estimated and potentially biased high.
- 4. Based on MD/MSD recoveries discussed in Subsection D.3.1.2, Appendix D, positive results for 4,4-DDT in soil samples collected at AOC 57 should be considered estimated and potentially biased high.
- 5. Based on spike recoveries for hardness (Appendix D, Subsection 3.3.3), all hardness results for groundwater samples should be considered invalid, with the exception of groundwater sample MXG302X1 in which acceptable hardness recoveries were reported.
- 6. Low TPHC MS spike recoveries were reported in sediment sample DX570500 from AOC 57. All positive sediment sample results for TPHC for AOC 57 sediments should be considered estimated and biased low, and all non-detect results should be considered invalid.
- 7. SVOC surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.1:
 - Surrogate standard 2,4,6-tribromophenol in AOC 57 soil sample EX571602 was less than 10 percent. All non-detect results in the acid fraction of this sample are rejected and considered unusable.
- 8. VOC surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.1:
 - Groundwater sample MX5703X1, had high surrogate recoveries for 1,2-dichlorobenzene-D4. Positive results for ethylbenzene, tetrachloroethene, toluene, xylenes, and chloromethane reported in MX5703X1 are considered estimated and potentially biased high.
 - The recovery of surrogate standard 1,2-Dichloroethane-D4 in surface water sample WX5704XX from AOC 57 was high. Positive results

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reported for 1,2-dichloroethene, tetrachloroethene, and trichloroethene in surface water sample WX5705XX are considered estimated and potentially biased high.

- 9. Outlier duplicate RPDs for sediment sample DX570300 from AOC 57 were reported (Subsection D.4.1.1, Appendix D). Based on these results, concentrations of mercury, manganese, sodium, and zinc in sediment samples from AOC 57 should be considered estimated.
- 10. Based on field duplicate RPDs (Subsection D.4.1.4, Appendix D), positive results in surface water samples from AOC 57 for nitrogen determined by the kjeldahl method, hardness, and total phosphate should be considered estimated.
- 11. Positive detections of endosulfan II in AOC 57 groundwater sample EX5706X1 are considered estimated based on RPD exceedances between spiked sample results (Subsection D.4.2.2 in Appendix D).

Groundwater, Round 2 (February 1996).

- 1. Based on low spike recoveries for lead and selenium (Subsection D.3.3.3, Appendix D), results reported at the CRLs for these elements in AOC 57 groundwater samples should be considered estimated and potentially biased low. Lead and selenium were not detected groundwater samples.
- 2. Based on low spike recoveries discussed in Subsection D.3.3.3, Appendix D, antimony CRLs for groundwater samples are considered estimated and potentially biased low. Antimony was not detected in any groundwater samples.
- 3. Phosphate results from AOC 57 groundwater samples are considered estimated values based on outlier RPDs between field duplicate results.
- 4. The concentration of 1,3,5-trimethylbenzene in groundwater sample MX5703X2 and the duplicate MD5703X2 are considered estimated based on duplicate RPDs results.

AOC 57 Fall 1996 RI

- 1. Based on MS recoveries discussed in Appendix D, Subsection D.3.1.1, positive detections and results reported at the CRL for mercury, arsenic, and manganese in soil are considered estimated values and potentially biased low based.
- 2. Based on MS recoveries discussed in Appendix D, Subsection D.3.1.2, lindane CRLs in AOC 57 groundwater samples may be biased low and should be considered estimated. Lindane was not detected in groundwater samples.
- 3. Based on MS and MSD recoveries for TPHC (Method 9071) discussed in Appendix D, Subsection D.3.1.3, positive results in AOC 57 soil sample EX573106 are considered estimated and potentially biased low.
- 4. VOA surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.2:
 - Soil sample EX572810 from AOC 57 had surrogate recoveries for 4bromoflourobenzene above the control limits. Concentrations of 2hexanone, ethylbenzene, tetrachloroethene, and xylenes in this sample are considered estimated and potentially biased high.
 - The concentrations of 2-hexanone and xylenes reported in AOC 57 soil sample EX573006 are considered estimated and potentially biased high.
- 5. Pesticide/PCB surrogate recovery evaluations are presented in Appendix D, Subsection D.3.2.3:
 - Low recoveries of surrogate standard decachlorobiphenyl in AOC 57 groundwater samples MD5711X1, MX5712X1 for PCBs were reported. PCBs were not detected in these samples and CRLs are considered estimated and potentially

biased low.

- Low recoveries of surrogate standard decachlorobiphenyl in AOC 57 groundwater samples MX5713X1, MX5703X3 for pesticides were reported. Pesticides were not detected in these samples and CRLs are considered estimated and potentially biased low.
- The result for Aroclor-1260 in AOC 57 soil sample EX572810 is considered estimated and potentially biased-low. Low surrogate recoveries for surrogate standards tetrachlorometaxylene and decachlorobiphenyl were reported.
- 6. Based on duplicate precision evaluations presented in Appendix D, Subsection D.4.1.5, TPHC soil results are considered estimated.
- 7. Concentrations of 1,2,3-trimethylbenzene in soil sample MX5711X1 are considered estimated based on duplicate evaluations presented in Appendix D, Subsection D.4.1.3.

1998 Supplemental Field Investigation

- 1. Based on VOA surrogate data presented in Appendix D-4, Subsection 2.4, Results for benzene, chlorobenzene, and toluene in samples DX570600 are potentially biased high.
- 2. Based on SVOA surrogate data presented in Appendix D-4, Subsection 2.4, results for WX570300 (57W-98-03X) and WX570400 (57W-98-04X) indicate a low bias for base/neutral compounds in these samples. Base/neutral compounds include all non-phenolic compounds.
- 3. Based on pesticide surrogate data presented in Appendix D-4, Subsection 2.4, all results for pesticides in water sample MX570200 (57W-98-02X), sediment sample DX570500 (57D-98-05X), and soil samples SX570302 (57S-98-03X) and SX570701 (57S-98-07X) are considered estimated and

potentially biased low.

- 4. Based on PCB surrogate data presented in Appendix D-4, Subsection 2.4, results for water sample WX570400 (57W-98-04X) are considered estimated and potentially biased low.
- 5. Based on matrix spike results presented in Appendix D-4, Subsection 2.5, antimony soil results are for method JS16 are considered to be estimated and potentially biased low.
- 6. Based on field duplicate data presented in Appendix D-4, Subsection 2.6, results for barium in all water samples should be considered estimated values, and all TSS data should be considered estimated.

7.1.3.2 On-site Laboratory Data Use Considerations. A detailed review of quality control sample measurements from the on-site laboratory program is presented in Appendix D. Data use considerations are summarized below:

- 1. Chloroform was detected in a laboratory method blank (390 μ g/g) indicating this compound may be reported in samples as a result of laboratory contamination.
- 2. Based on field duplicate results for the TPHC modified 418.1 method discussed in Appendix D, Subsection D.4.2, reporting limits and low concentration ($<100 \mu g/g$) detected results are considered estimated values.
- 3. Based on field duplicate results for VOCs discussed in Appendix D, Subsection D.4.2, VOC results for soils should be considered estimated values.

1998 Supplemental Field Investigation

1. Based on discussions in Appendix D-4, Subsection 3.1.1, TPHC field screening results for sediments may be biased high.

7.2 AOC 57 INVESTIGATIONS

7.2.1 Previous Investigations

The following subsection details the analytical findings of the previous investigations conducted at AOC 57. AOC 57 has been divided into three sub-areas, Area 1, Area 2, and Area 3 (Figure 5-2). Area 1 has been the subject of previous investigations and was not included in the investigative phase of this RI. Results of investigations at Area 1 are included, however, in this RI report for completeness.

7.2.1.1 1992 Site Investigations. HLA conducted an SI at Areas 1 and 2 of AOC 57 (then SA 57) in September 1992. The objective of the SI was to investigate the presence or absence of environmental contaminants in the different environmental media found at AOC 57, reportedly as a result of a February, 1977 fuel oil spill. A detailed description of the results of the SI are presented in the Revised Final Groups 2, 7, and Historic Gas Station SI Report (ABB-ES, 1995a).

Samples of surface soil, surface water, and sediment were collected from Areas 1 and 2 during the SI. PAHs and TPHC possibly associated with the fuel oil were detected in surface soils at Area 1 (57S-92-01X through 57S-92-03X) (Figure 5-4). The human health PRE, which was conducted to evaluate potential exposure to the detected PAH compounds and TPHC, indicated that there was no unacceptable health risk for the presumed commercial/industrial future site use. Because Area 1 is part of the storm water drainage network which discharges into Cold Spring Brook, the Army recommended that this area be further investigated as part of the installation-wide AREE 70 storm water study.

At Area 2, naphthalene and TPHC were detected in surface soils during the SI (57S-92-06X through 57S-92-08X). Fingerprint analysis of soil from Area 2 indicated that contaminated soil was most likely derived from lubricating oil, possibly from the release of vehicle crank case oil. Given this finding, the contaminants found at Area 2 were not likely related to the 1977 release of No. 4 fuel oil. Results of the human health and ecological PREs indicated that the chemical hazards at Area 2 were not significant. However, the PREs were performed just prior to promulgation of MCP soil standards. In consideration of the new standards, the Army proposed that a removal action (focused on TPHC) be conducted.

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The following subsections present a detailed summary of analytical results by medium, at Area 2. A discussion of subsequent soil removal activities at Area 2 is also presented.

Surface Soil

Three surface soil samples (57S-92-01X, 57S-92-02X, and 57S-92-03X) were collected from the Area 1 storm drain outfall and drainage ditch (Figure 5-4). Several PAHs were detected in samples 57S-92-02X and 57S-92-03X. The total PAH detected ranged from 35.5 μ g/g in 57S-92-02X to 36 μ g/g in 57S-92-03X. TPHC was detected in all three surface soil samples collected. TPHC concentrations ranged from 1,410 μ g/g in 57S-92-02X to 2,210 μ g/g in 57S-92-03X (Table 7-5).

Three surface soil samples were collected from stained areas within the drainage ditch at Area 2 (57S-92-06X through 57S-92-08X). These samples were collected to assess the distribution of contaminants along the ditch (Figure 5-4). Each sample was submitted for analysis of Project Analyte List (PAL) SVOCs, TPHC, Total Organic Carbon (TOC), petroleum fingerprinting, and grain size.

Analysis of surface soil samples detected naphthalene at a concentration of 0.3 μ g/g at 57S-92-07X. TPHC were detected at each surface soil sample location, at concentrations ranging from 606 μ g/g at 57S-92-08X to 4,910 μ g/g in the duplicate sample at 57S-92-07X. Fingerprint analysis of soil from Area 2 indicated that contaminated soil was most likely derived from a release of vehicle crank case oil. Table 7-5 presents the SI surface soil analytical results.

The PRE conducted to evaluate potential exposure to the detected PAH compounds, and for TPHC, indicated that there was no unacceptable health risk for commercial/industrial site use at either Areas 1 or 2. The concentrations of naphthalene and TPHC were determined to be well below their respective ecological benchmark values. However, in consideration of the source of contaminants, the ecological PRE established that it was unknown whether or not concentrations of analytes other than SVOCs may be contributing to ecological risk at the site. It should be noted that the 1992 PREs were performed prior to promulgation of MCP soil standards.

Surface Water and Sediment

Two surface water and sediment samples were collected from Cold Spring Brook during the SI. One surface water and sediment sample location was located approximately 1,000 feet upstream (57D-92-01X), and one was located approximately 3,000 feet downstream (57D-92-02X) of AOC 57/Area 2, to assess if contaminants from AOC 57/Area 2 were impacting the surface water and sediment quality in the Brook (Figure 5-4). In addition, surface water and sediment samples were collected from Cold Spring Brook during the Group 3 site investigations conducted in June 1992. One location (G3D-92-01X) was located immediately upstream from AOC 57/Area 2, while one (G3D-92-02X) was located just downstream of Area 2 (Figure 5-4). Historical surface water and sediment analytical data are presented in Appendix E.

Two rounds of surface water and sediment sampling were conducted during the SI. The first round of surface water samples from these two locations was analyzed for PAL SVOCs, TPHC, and PAL water quality parameters. The first round of sediment samples was analyzed for PAL SVOCs, TPHC, TOC, and grain size. The second round of sampling involved resampling surface water and sediment from 57D-92-01X, and surface water only at 57D-92-02X. The second round of surface water samples was analyzed for PAL VOCs, PAL SVOCs, PAL inorganics, and TPHC. The additional sediment sample was analyzed for PAL VOCs, PAL SVOCs, PAL inorganics, TPHC, and TOC.

Surface water analytical results indicated the presence of chloroform at a concentration of $1.1 \ \mu g/L$, in the second surface water sample collected from 57D-92-01X. No other organic compounds were detected in the surface water samples. Cation/anion concentrations remained relatively constant in each surface water sample collected from Cold Spring Brook. Results of the Group 3 upstream surface water sample (G3D-92-01X) were consistent with 57D-92-01X, the SI upstream sample. The Group 3 downstream sample (G3D-92-02X) results were very similar to the upstream sample (G3D-92-01X).

Sediment sampling results indicated the presence of PAHs and TPHC at sampling locations 57D-92-01X and 57D-92-02X. PAHs increased in number and in concentration at the downstream location (57D-92-02X), and were not detected at all at the upstream location (57D-92-01X) during the second sediment sampling event. TPHC concentrations were higher at the upstream location (57D-92-01X). The TPHC concentration of the sole sediment sample collected at 57D-92-02X was 92.6 μ g/g. The TPHC concentrations at

57D-92-01X were 497 and 466 μ g/g from Round 1 and Round 2 respectively. Several inorganic analyte concentrations appeared to be consistent in the upstream and downstream sediment samples collected from Cold Spring Brook.

The Group 3 sediment results indicated the presence of VOCs, SVOCs, TPHC, and various inorganics in both the upstream and downstream samples. The concentrations of detected analytes were similar in both the upstream and downstream samples. From these data, it was unclear as to whether AOC 57 Areas 1 and 2 were impacting sediment quality. The analytical results did show that additional contamination was entering Cold Spring Brook from a source(s) further upstream.

A human health and ecological risk PRE of surface water and sediment samples collected from Cold Spring Brook was not conducted during the SI. Results from sampling of this medium were evaluated during the AREE 70 study (ADL, 1994) and Lower Cold Spring Brook Study (ABB-ES, 1995c).

7.2.1.2 AREE 70 Investigation. The AREE 70 investigation gathered information on 55 storm drain systems and three surface water bodies, and identified potential sources of contamination that were not identified through previous investigations. Included in the AREE 70 evaluation was Storm Drain System 6 (AOC 57 Area 1). Three sediment and two water samples were collected at three locations within the drainage ditch (SSD/SSW-93-06A, SSD/SSW-93-06B, and SSD-93-06C) (Figure 5-4). Of these samples only SSD/SSW-93-06B is located within AOC 57. Analyses of the surface water and sediment samples indicated elevated levels of arsenic, chromium, and lead in sediment and arsenic and lead in water. SSD-93-06B, located at the Area 1 storm system outfall adjacent to Barnum Road, also had the highest concentration of total PAHs (59.8 μ g/g) and a higher TPHC concentration than the upgradient system samples SSD/SSW-93-06A and SSD-93-06C. Results of the sampling were incorporated into the Lower Cold Spring Brook Study ecological PRE. Historical surface water and sediment analytical data are presented in Appendix E.

7.2.1.3 Area 2 Soil Removal Activities. The results of the human health and ecological PREs performed in conjunction with the Groups 2 and 7 SI indicated that the chemical hazards at Areas 1 and 2 were not significant. However, the PREs were performed prior to promulgation of MCP soil standards. In consideration of the new soil standards, the Army proposed that a soil removal action (focused on TPHC) be conducted at Area 2.

In October of 1993 eight additional surface soil samples (57S-93-10X through 57S-93-17X) were collected from the drainage ditch area and screened for TPHC to aid in determining the extent of contamination requiring removal (Figure 5-4 and Table 7-6).

Subsequently, HLA prepared a document entitled "Final Action Memorandum, SA 57 Barnum Road Oil Spill Area 2, Fort Devens, Massachusetts" in June 1994. The Action Memorandum documented the decision to perform a removal action to address petroleumcontaminated soil in the drainage ditch at Area 2. The proposed clean-up objective outlined in the Action Memorandum was to remove surface soil within areas of petroleum staining, and historically high TPHC concentrations, to a TPHC concentration less than 500 milligrams per kilogram (mg/kg). The Action Memorandum estimated that a limited amount of soil needed to be excavated.

A removal action began on August 26, 1994 and continued until September 12, 1994. Soil was excavated using standard excavating equipment. Erosion control measures were taken during the excavation to prevent erosion and sedimentation of soil into the Cold Spring Brook wetland. Soil samples were collected for field analysis of TPHC as each area was excavated (Figure 5-5 and Table 7-7). TPHC was detected in these samples up to a maximum concentration of 74,208 mg/kg. Black, oily soil was detected at approximately 18 inches bgs in an excavation, at the base of the slope. This soil was sampled for laboratory analysis for metals, SVOCs, TPHC, and VOCs (Table 7-8). TPHC was detected at concentrations ranging from 29,300 to 50,100 mg/kg, and lead was detected at concentrations ranging from 137 to 464 mg/kg. The VOCs ethylbenzene, toluene, and xylenes were detected in the soil samples. SVOCs were not detected; however, detection limits were elevated due to dilution of the samples.

Continued excavation efforts revealed stained soil laterally and at depths in excess of original estimates. A trench was excavated to the water table in the southern-most portion of Area 2 to define the extent of contamination. An oily sheen was observed on water in the trench. The water in this trench was analyzed for TPHC, PCBs, metals, SVOCs and VOCs. This sample contained elevated TPHC (754,000 mg/L) and PCBs (140 mg/L). Petroleum fingerprinting indicated that the oil was most likely a mixture of kerosene and lubricating oil.

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The trench was not successful in determining the limits of contamination so test pits were subsequently excavated outside the previously excavated area (Figure 5-4). Soils collected from the test pits were field screened to determine the extent of TPHC-contaminated soil (Table 7-7). Soon after starting the test pit excavation, it became clear that contamination extended well beyond the limits originally estimated, and the removal action was suspended until Area 2 could be better characterized. A total of approximately 1,300 cubic yards of soil was ultimately excavated from Area 2, before it was lined with 6-mil polyethylene, backfilled with clean soil, and covered with an erosion control blanket. A drainage swale was constructed and lined with 6-inch riprap to channel runoff to the Cold Spring Brook wetland.

7.2.1.4 Lower Cold Spring Brook Study. In 1994, HLA conducted an SI at Lower Cold Spring Brook to evaluate surface water and sediment quality. Samples were collected from 23 locations in Lower Cold Spring Brook and 11 locations in storm drain ditches and swales. Of these six surface water and sediment pairs (CSD-94-13X, -14X, -17X, -19X, -20X, and -35X) were collected from Lower Cold Spring Brook in the vicinity of AOC 57/Area 2 and four surface water and sediment pairs (CSD-94-16X, CSD-94-18X, CSD-94-26X, and CSD-94-22X were collected from the area of Cold Spring Brook that is hydrogeologically downgradient of the area that would become Area 3 (Figure 5-6). The surface water samples were analyzed for PAL SVOCs, total and dissolved inorganics, and water quality parameters, TSS, chloride, sulfate, total hardness, and alkalinity. These surface water samples were also analyzed in the field for pH, dissolved oxygen, conductivity, and temperature. The sediment samples were analyzed for PAL VOCs, PAL SVOCs, PAL inorganics, TOC, TPHC, grain size distribution, and percent solids. At four of the locations, CSD-94-13X, CSD-94-18X, CSD-94-20X, and CSD-94-27X, the macroinvertebrate community was characterized, and sediment samples were subjected to toxicity testing. At these four locations, surface water and sediment samples were also analyzed for pesticides and PCBs. The data was subjected to an ecological PRE. The findings of this SI were presented in the "Lower Cold Spring Brook Site Investigation Report", submitted in December 1995. Analytical data are presented in Appendix E.

Analytical results from the brook in the vicinity of Area 2 indicated that the marsh located upstream of the 1977 containment dike contained sediments with elevated concentrations of VOCs, SVOCs, pesticides, PCBs, and inorganics. TPHC was detected at a maximum concentration of 2,700 mg/kg. SVOCs were detected at concentrations that marginally exceeded screening values, while pesticides, PCBs, and inorganics significantly exceeded

screening values. Lead was detected in surface water at a concentration above the Ambient Water Quality Criteria (AWQC). Pesticides and the maximum concentrations of inorganics in sediment were found in the sample from location CSD-94-20X located on the upstream side of the containment dike adjacent to AOC 57 Area 2. The ecological PRE showed no risks to aquatic receptors from surface waters at that location.

Macroinvertebrate and aquatic toxicity results did not indicate any increased mortality relative to aquatic receptors, although this station contained the poorest habitat relative to the control area. Despite the demonstrated lack of increased mortality, the ecological PRE indicated that there may be limited ecological risks associated with Area 2 marsh sediments.

Results of samples collected from the portion of Cold Spring Brook hydrogeologically downgradient of Area 3 showed decreased concentrations of SVOCs, TPHC, and inorganics as compared to the samples collected upstream (e.g., Area 2 samples and G3D-92-02X). Further discussion of these sample results is provided in Subsection 7.2.4, RI Sediment.

7.2.1.5 Area 1 Contaminated Soil Removal. Although the Lower Cold Spring Brook PRE for Area 1 showed that there were no identifiable ecological risks, it was decided to perform a contaminated soil removal at the outfall to address soil contamination resulting from releases of petroleum oil.

Excavation of outfall soils commenced in February of 1997. Initial removal operations included excavation of a 15-foot by 15-foot area to a maximum depth of 2 feet bgs at the outfall location. Following the initial excavation, four composite samples were collected for on-site TPHC screening. TPHC values in these composite samples ranged between 66 and 271 ppm. Six confirmatory samples (AOC-57, A1-SW1, SW2, SW3, SW4, FL1, DUP) were also collected and submitted for off-site analyses for EPH/VPH and metals to verify the on-site screening (Figure 5-7).

EPH $C_{10} - C_{22}$ aromatic fraction in excess of MCP S-1/GW-1 standards were detected in sidewall samples (Table 7-9). Based upon these data, an additional three feet of soil was excavated from the sidewalls perpendicular to the outfall pipes and approximately seven feet was excavated from the wall opposite the outfall pipes. The maximum depth of excavation was three feet bgs. Following the second phase of excavation, an additional three confirmatory samples were collected from the sidewalls (AOC 57-A1-SW1/B, SW2/B and SW4/B) (Figure 5-7 and Table 7-9). Confirmatory analytical results for the second

round of sampling indicated elevated PAH concentrations in sidewalls AOC 57-A1-SW1/B and SW4/B. A total of 10 PAH contaminants exceeded the applicable MCP S-1/GW-1 standards with the highest concentrations located downstream of the outfall pipes.

A statistical comparison of the arithmetic mean concentration of the PAHs indicated that the types and concentrations of PAHs in sediments at the Area 1 outfall are consistent with concentrations at various outfalls along Cold Spring Brook (Weston, 1998). This analytical data strongly indicates that fuel oil related contamination at the outfall was successfully removed, and what remains in soil and sediment at the outfall are PAHs that are likely related to runoff from paved, trafficked along Barnum Road. This type of PAH contamination, which cannot feasibly be eliminated from runoff from asphalt paved areas, is specifically exempted from MCP requirements due to its relative ubiquity at these types of outfalls.

7.2.2 AOC 57 RI and Removal Action Soils Results

The following subsections present field and off-site laboratory analytical soil results for samples collected at AOC 57 Areas 2 and 3 during the RI. Field analytical soil data are presented in Tables 7-10, 7-11 and 7-13. Off-site laboratory analytical soil data are presented in a hits-only format in Tables 7-12 and 7-13. Complete field analytical and off-site laboratory analytical soil data are presented in Appendix M.

7.2.2.1 Field Analytical Soil Results. Soil samples were collected for field analysis from TerraProbeSM points, soil borings, test pits, and surface soil sampling points. The field analytical samples were collected in an attempt to define the nature and distribution of the site-related contaminants as well as to delineate potential contaminant source areas. A discussion of the results for Areas 2 and 3 is presented below.

Area 2

RI Test Pit Soil Sampling Field Analytical Results. A total of 23 test pits, 57E-95-01X through 57E-95-20X and 57E-95-25X through 57E-95-27X, were excavated at Area 2 in 1995. Sixty-nine soil samples were collected from the test pits for on-site analysis of BTEX, select VOCs, GRO, and TPHC. Soil samples were collected based upon visual evidence or PID screening. In the absence of overt contamination, samples were generally collected at the surface, midpoint and bottom of the excavation. On-site analytical results

for the test pit soils are provided in Table 7-10.

Toluene, ethylbenzene, chlorobenzene, m/p xylene, or o-xylene were detected in seven samples from the Area 2 test pits 57E-95-01X, 57E-95-06X, 57E-95-07X, 57E-95-12X, 57E-95-15X, 57E-95-16X, and 57E-95-17X. Total detected concentrations ranged between 3.2 μ g/kg (toluene) at 2 feet bgs from 57E-95-01X to 109,400 μ g/kg (combined toluene, ethylbenzene, m/p-xylene, and o-xylene) in the 4 foot bgs sample from 57E-95-07X. In general, the TEX detections were concentrated around the southern portion of the soil removal excavation.

Chlorinated hydrocarbons were detected in three samples. 1,1-DCE exceeded the detection limit of 6100 in the 4 foot bgs sample from 57E-95-07X. PCE was found in the 2 foot bgs sample from 57E-95-15X and at 3 feet bgs in 57E-95-20X at concentrations of 4.8 and 2.5 μ g/kg, respectively. The 5 foot bgs sample from 57E-95-17X contained 21 μ g/kg of TCE. As with the TEX distributions, the TCE and PCE detects were located around the southern portion of the soil removal excavation.

Soil samples from AOC 57 Area 2 were also analyzed for TPHC by IR (Method 418.1) and GRO. TPHC was detected in 25 of the soil samples with a maximum observed concentration of 65,000 mg/kg at 4 feet bgs in 57E-95-07X. This sample also corresponded to the maximum GRO detection of 8,600,000 μ g/kg. GRO was detected in seven of the 69 total samples. Figure 7-1 shows TPHC detections in subsurface soils as determined by onsite analysis. The highest concentrations were observed along the southern portion of the soil removal excavation, 1,400 mg/kg at 0 feet in 57E-95-08X, 3,400 and 2,000 mg/kg at 0 and 2 feet respectively in 57E-95-17X, 8,000 mg/kg at 3 feet in 57E-95-16X, 9,700 mg/kg at 0 feet in 57E-95-07X. TPHC was also found in the northern portion of the site in surficial soils with a maximum concentrations in the northern portion of the site are attributed to the observed coal ash layer.

RI Soil Boring Field Analytical Results. Soil samples were collected for field analysis from four soil borings (57B-95-03X, 57B-95-04X, 57B-95-05X, and 57B-95-06X,) three monitoring well borings (57M-95-07X, 57M-95-08A, and 57M-95-08B) and a piezometer boring (57M-95-01A) to provide data on contaminant distribution, aid in the selection of samples for off-site analysis, and confirm monitoring well location. Soil boring and

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TerraProbeSM field analytical results are provided in Table 7-11. Soil samples were collected from the soil borings 57B-95-03X at 0 and 5 feet bgs; 57B-95-04X at 15 feet bgs; 57B-95-05X at 15 feet bgs; and 57B-95-06X at 12 feet bgs. The monitoring well and piezometer borings 57M-95-07X, 57M-95-08A, 57M-95-08B, and 57P-95-01A were sampled at 4, 7, 4, and 5 feet bgs, respectively. All samples were analyzed in the field laboratory for BTEX, select VOCs, and TPHC by NDIR and GC. BTEX and chlorinated solvents were below detection limits for all of the samples. TPHC was detected by NDIR at 480 mg/kg at 0 feet bgs in 57B-95-03X and at 65 mg/kg at 4 feet bgs in 57M-95-08B.

1998 Surface and Subsurface Soil Sampling Field Analytical Results

In May of 1998, additional surficial and subsurface soil sampling was performed to better define downgradient soil contamination. Two soil samples, one at the ground surface and one at the water table, were collected from 10 locations at Area 2 (57S-98-01X through 57S-98-10X). Sample locations were selected to best characterize the soils south (downgradient) of the removal excavation and the explorations showing the highest historical levels of petroleum and chlorinated VOC contamination (i.e., test pits 57E-95-15X, 57E-95-16X, and 57E-95-07X). Sample depths ranged between 0 and 3 feet bgs. All 20 samples were screened at the on-site laboratory for TPHC by NDIR.

TPHC concentrations ranged between 32,000 μ g/g at 1-foot bgs from 57S-98-07X to less than 210 μ g/g at the ground surface from 57S-98-05X (Figure 7-2 and Table 7-13). The distribution of TPHC detections was consistent with the earlier RI findings in that the highest concentrations were found adjacent to the southern extent of the Area 2 Removal Action excavation. Screening results south of test pits 57E-95-15X and 57E-95-16X, 570 μ g/g at 0 feet and 680 μ g/g at 1-foot bgs from 57S-98-04X; 920 μ g/g at 0 feet and 2500 μ g/g at 1-foot bgs from 57S-98-06X; and <800 μ g/g at 0 feet and <270 μ g/g at 1-foot bgs from 57S-98-08X, indicate that the elevated TPHC concentrations have not migrated further toward the wetland on the south and southeast side of the excavation. However, elevated TPHC was detected in the 2-foot bgs sample collected from 57S-98-03X suggesting that contamination detected in 57E-95-07X has migrated toward the wetland. Impacts to Area 2 wetlands are further discussed in Subsection 7.2.4, RI Sediment.

Area 3

RI Test Pit Soil Sampling Field Analytical Results. A total of eight test pits were excavated at Area 3, 57E-95-21X through 57E-95-24X in 1995 and 57E-96-28X through 57E-96-31X in 1996. Forty soil samples were collected from the test pits for on-site analysis of BTEX, select VOCs, and TPHC. Soil samples were collected based upon visual evidence or PID screening. On-site analytical results for the test pit soils are provided in Table 7-10.

Detected VOCs include chlorobenzene, ethylbenzene, m/p-xylene, o-xylene, chloroform, and naphthalene. The VOCs were detected mainly in the vicinity of test pit 57E-95-24X and 57E-96-28X through 57E-96-31X. It should be noted that naphthalene and the dichlorobenzene suite were not calibrated for until near the end of the test pitting program; therefore, only soil samples from test pit 57E-96-31X were analyzed for these compounds. The maximum observed VOC concentrations were found in the 10 feet bgs sample from 57E-96-31X with ethylbenzene reported at 8,800 μ g/kg, m/p-xylene at 26,000 μ g/kg, o-xylene at 9,900 μ g/kg, and naphthalene at an estimated ("J" qualified) concentration of 12,000 μ g/kg.

Soil samples from AOC 57 Area 3 were also analyzed for TPHC by IR (Method 418.1) and GRO (1995 samples only). TPHC was detected in 26 of the soil samples with a maximum concentration that exceeded the detection limit 63,000 mg/kg at 4 feet bgs in 57E-96-31X. Figure 7-3 shows contours of TPHC detections in surface and subsurface soils as determined by on-site analysis.

RI TerraProbeSM and Soil Boring Field Analytical Soil Sample Results. A total of 87 soil samples were collected from 20 TerraProbeSM points, six soil borings and one monitoring well boring to aid in the delineation of horizontal and vertical contaminant distribution, determine the source of the contamination, and confirm monitoring well placement. Soil samples were analyzed in the field laboratory for BTEX, select VOCs, TPHC, and GRO (1995 only). Field analytical soil data are presented in Table 7-11.

Detected VOCs included ethylbenzene, toluene, chlorobenzene, m/p-xylene, o-xylene, naphthalene, 1,1-DCE, 1,2-DCB, and 1,4-DCB. Chloroform was also detected in three of the samples but was linked to blank contamination. Naphthalene and the dichlorobenzene suite were not calibrated for until after commencement of the 1996 sampling program;

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therefore, soil samples from TerraProbeSM points 57R-96-07X through 57R-96-12X at 6 feet bgs were not analyzed in the field for these compounds.

Naphthalene was detected in the soil borings 57B-96-07X (0, 5 and 10 feet bgs) and 57B-96-12X at 5 feet bgs as well as the TerraProbeSM points 57R-96-13X (3 and 5 feet bgs), 57R-96-14X (3 feet bgs), 57R-96-15X (3, 5, and 9 feet bgs), 57R-96-16X (3 feet bgs), and 57R-96-19X (9 feet bgs). Estimated naphthalene concentrations ranged between 440 μ g/kg and 27,000 μ g/kg in the 10 and 5 foot bgs samples from 57B-96-07X. 1,2-DCB and 1,4-DCB were detected in four samples; 57B-96-07X (5 feet bgs), 57R-96-15X (5 and 9 feet bgs), and 57R-96-19X (1,2-DCB only at 9 feet bgs). The maximum observed concentrations of 1,2-DCB and 1,4-DCB were 46,000 and 14,000 μ g/kg in the 5 foot bgs sample from 57B-95-07X. DCB hits were found coincident with the higher concentrations of naphthalene, ethylbenzene and xylenes.

Other detected VOCs included 1,1-DCE at 370 μ g/kg in the 10 foot bgs sample from 57B-96-09X and an estimated concentration of 5.4 μ g/kg in the surficial sample from 57R-95-01X. Chlorobenzene was detected in 57B-96-12X at 5 feet bgs at a concentration of 4,700 μ g/kg, in 57R-95-04X at 10 feet at a concentration of 49 μ g/kg, and the 10 feet bgs duplicate sample from 57R-96-10X at a concentration of 300 μ g/kg.

TPHC were detected in 37 of the soil samples collected from Area 3 soil borings and TerraProbeSM points. The maximum observed concentration was 39,000 mg/kg in the 5 feet bgs sample from 57R-96-13X. Other significant detections (e.g., in excess of 500 mg/kg) include the 0 and 5 feet bgs samples from 57B-96-07X at 12,000 and 14,000 mg/kg, respectively, the 5 feet bgs sample from 57B-96-11X at 7,400 mg/kg, the 5 feet bgs sample from 57B-96-11X at 7,400 mg/kg, the 5 feet bgs sample from 57B-96-12X at 13,000 mg/kg, the 4 feet bgs sample from 57R-95-05X at 4,500 mg/kg, the 3 and 5 feet bgs samples from 57R-96-13X at 9,400 mg/kg, the 3, 5, and 9 feet bgs samples from 57R-96-15X at 12,000, 12,000, and 14,000 mg/kg, respectively, and the 9 feet bgs sample from 57R-96-19X at 700 mg/kg. TPHC contamination is approximately coincident with the VOC contamination and is located from the vicinity of test pit 57E-95-24X to the soil boring 57B-96-12X. Pre-removal action distribution of Area 3 TPHC contamination as determined by field analytical results is provided in Figure 7-3.

1998 Surface and Subsurface Soil Sampling Field Analytical Results.

In May of 1998, additional surficial and subsurface soil sampling was performed to better define downgradient soil contamination at Area 3. Two soil samples, one at the ground surface and one at the water table, were collected from six locations at Area 3 (57S-98-11X through 57S-98-16X). Sample depths ranged between 0 and 3 feet bgs. All 12 samples were screened at the on-site laboratory for TPHC by NDIR.

TPHC concentrations ranged between 2,900 μ g/g at 0 feet from 57S-98-14X to less than 260 μ g/g at 2 feet bgs from 57S-98-16X (Table 7-13). The highest concentrations of TPHC were found adjacent to monitoring well 57M-96-11X were 57S-98-13X at 1-foot bgs contained 1,600 μ g/g and 57S-98-14X at 0 feet contained 2,900 μ g/g. The 1998 TPHC field analysis is combined with the earlier RI data and contoured in Figure 7-3. The 1998 TPHC data is provided along with 1998 off-site TPHC and EPH/VPH data in Figure 7-4.

7.2.2.2 Off-Site Laboratory Soil Analytical Results.

Area 2

RI Test Pit Soil Sampling Off-Site Analytical Results. A total of 19 soil samples were collected for off-site laboratory analysis from the 23 test pits excavated at AOC 57 Area 2 in 1995. Samples were collected from depths ranging from the ground surface to 6 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganics analysis indicated that arsenic, barium, calcium, cadmium, chromium, cobalt, copper, nickel, lead, selenium, silver, sodium, and zinc were present in concentrations that exceeded established background concentrations for Devens soils. The majority of exceedances were located around the southern portion of the soil removal excavation at depths coincident with the observed TPHC and VOC contamination. The surficial sample from 57E-95-25X, located on the northern portion of the site towards Barnum Road, also showed limited exceedances of background concentrations.

Detected VOCs are comprised of TEX, PCE, TCE, and 1,2-DCE. The common laboratory contaminants 2-hexanone, acetone, dichloromethane (methylene chloride) and trichlorofluoromethane (freon) were detected in a number of AOC 57 Area 2 soil samples. These compounds, as well as toluene, were identified in soil blanks or rinsate blanks (see Subsection 7-1 and Tables 7-2 and 7-3).

VOC detections in soil are concentrated around the soil removal excavation in test pits 57E-95-07X, 57E-95-10X, 57E-95-12X, 57E-95-15X, 57E-95-16X, and 57E-95-17X. TEX were also detected in the surficial sample from 57E-95-02X. The highest levels of VOCs were observed in 57E-95-07X in 4 feet bgs with total TEX of 0.344 μ g/g, 0.0039 μ g/g of 1,2-DCE, 0.011 μ g/g of TCE, and 0.0059 μ g/g of PCE.

SVOC detections were limited to six of the test pit soil samples and consisted of 2methylnaphthalene, fluoranthene, naphthalene, phenanthrene, pyrene, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate. Although only two SVOC analytes were detected, 2methylnaphthalene and naphthalene, the 4 feet bgs sample from 57E-95-07X contained the highest concentration of total SVOCs at 12 $\mu g/g$.

The pesticides 4,4-DDE and 4,4-DDT, 0.0199 and 0.0257 μ g/g respectively, were detected in the surficial sample from 57E-95-02X located adjacent to the drainage swale in the northern portion of the site. Pesticides and PCBs were detected in the southern portion of the site in explorations adjacent to the soil removal excavation. They included the pesticides dieldrin at a maximum observed concentration of 0.032 μ g/g in the surficial sample from 57E-95-17X, 4,4 DDE at 0.00928 μ g/g in the same sample, and Endosulfan I at 0.081 μ g/g in the 2 foot bgs sample from 57E-95-16X. PCBs were only detected in test pits 57E-95-012X, 57E-95-15X, 57E-95-16X, and 57E-95-17X, all located around the southern perimeter of the soil removal excavation. Maximum observed concentrations were 3.2 μ g/g of Aroclor-1248 and 12 μ g/g of Aroclor-1260 both from the 2 foot bgs sample from 57E-95-16X.

TPHC was identified in 15 of the test pit soil samples. Significant detections (e.g., >100 μ g/g) were limited to the perimeter of the soil removal excavation. Notable detections include 31,800 μ g/g in the 4 feet bgs sample from 57E-95-07X, 5,110 μ g/g in the surficial sample from 57E-95-12X, 26,100 μ g/g in the 2 feet bgs sample from 57E-95-15X, 30,000 μ g/g in the 2 feet bgs sample from 57E-95-16X, and 2,390 μ g/g in the surficial sample from 57E-95-17X.

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RI Soil Boring Off-Site Analytical Results. A total of 11 soil samples were collected from the six Area 2 soil borings, 57B-95-01X through 57B-95-06X. The soil borings were located on the mid- to northern portion of the site above the break in slope and treeline. Samples were collected from soil borings to allow for characterization of soils from greater depths than allowed by test pitting. Samples were collected from depths ranging from the ground surface to 21 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganics analysis indicated that cobalt, nickel, and sodium were present in concentrations that exceeded established background concentrations for Devens soils. Sodium was in exceedance of background in every soil boring sample. Exceedances of all other inorganics were limited to the surficial soil samples from 57B-95-01X and 57B-95-02X, both located on the northern portion of the site.

Acetone, dichloromethane (methylene chloride), toluene, and trichlorofluoromethane (freon) were the only VOCs detected. All of these compounds have been defined as possible sampling or laboratory contaminants. Observed toluene concentrations did not exceed $0.0045 \ \mu g/g$.

The SVOC compounds 2-methylnaphthalene, dibenzofuran, fluoranthene, naphthalene, phenanthrene, pyrene, and bis(2-ethylhexyl) phthalate were detected in the surficial samples from 57B-95-01X and 57B-95-02X. Total SVOC concentrations in 57B-95-01X was 4.174 μ g/g which includes 2.7 μ g/g of the probable laboratory contaminant bis(2-ethylhexyl) phthalate.

No pesticides or PCBs were detected in the soil boring samples.

TPHC was detected in seven of the soil boring off-site analytical samples. The only significant detections (e.g., in excess of 100 μ g/g) occurred in the surficial sample from 57B-95-02X, 7,970 μ g/g, and the duplicate sample collected at 5 feet bgs from 57B-95-02X, 138 μ g/g.

1998 Surface and Subsurface Soil Sampling Off-Site Analytical Results.

Ten samples from the 1998 soil sampling activities were selected for off-site analysis. Samples were collected from depths ranging between 0 and 3 feet bgs and analyzed at the off-site laboratory for EPH/VPH, TPHC, PAL VOCs, PAL SVOCs, PAL pesticides/PCBs, and select PAL inorganics. Samples were selected for off-site analysis based upon visual evidence, PID screening, and field analytical results. Off-site and on-site analytical results for the 1998 soil sampling are provided in Table 7-13.

The following inorganic analytes were detected at levels in excess of established Devens background concentrations; barium, copper, manganese, lead, zinc and arsenic. The highest concentrations of most of the individual analytes were found in the 0-foot sample from 57S-98-02X. Arsenic was found at a higher level in the 0-foot sample from 57S-98-07X. The bulk of the inorganic background exceedances were found in the surficial samples as opposed to the samples collected between 1 and 3 feet bgs.

Three VOC compounds were detected in the 1998 Area 2 soil samples; 1,2-DCE, ethylbenzene, and acetone. The 1-foot bgs sample from 57S-98-06X contained 0.01 μ g/g of 1,2-DCE and 0.003 μ g/g of ethylbenzene, 57S-98-07X at 0 feet had 0.33 μ g/g of acetone, and the 1-foot bgs sample contained 0.01 μ g/g of 1,2-DCE.

SVOC compounds were detected in several of the surficial soil samples. The highest total SVOC concentration, 8.4 μ g/g, was found in the 0-foot sample from 57S-98-02X (2-methylnaphthalene, acenaphtylene, benzo[k]flouranthene, chrysene, flouranthene, naphthalene, phenanthrene, and pyrene). The only other significant concentration of SVOCs was found in the 0-foot sample from 57S-98-08X which contained 5 μ g/g of total SVOCs (flouranthene, phenanthrene, and pyrene).

Pesticides were detected in seven of the 10 soil samples. The four compounds detected were dieldrin, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. The highest concentrations of total and individual pesticides were found in 57S-98-03X at 2 feet bgs, dieldrin at 0.043 μ g/g and 4,4'-DDD at 0.044 μ g/g, and 57S-98-09X at 0 feet, 4,4'-DDE at 0.0524 μ g/g and 4,4'-DDT at 0.018 μ g/g. The PCB congener Aroclor-1260 was detected in eight of the 10 samples collected. The highest concentration was found in the 2-foot bgs sample from 57S-98-03X which contained 5.2 μ g/g. All other detections were below 1 μ g/g.

TPHC concentrations in the 1998 Area 2 soil samples ranged between 17,000 μ g/g and 393 μ g/g. Detections in excess of 5,000 μ g/g include 17,000 μ g/g in 57S-98-07X at 1-foot bgs, 14,800 μ g/g in 57S-98-03X at 2 feet bgs, and 6,170 μ g/g in 57S-98-07X at 0 feet. TPHC detections were consistent with the contaminant distributions determined by the previous RI work. The highest concentrations were found in the area immediately south of the removal action excavation and test pits 57E-95-15X and 57E-95-16X.

The soil samples were also analyzed by EPH/VPH which is generally recognized as a more reliable means of determining concentrations of petroleum hydrocarbons. TPHC and EPH/VPH values are presented in Table 7-13 and Figure 7-2.

VPH fractions were detected at low levels in nine of the 10 samples analyzed. The highest concentrations were found in 57S-98-07X where the 0-foot and 1-foot samples each contained 15 μ g/g of the C9 to C12 aliphatic range (duplicate) and 21 μ g/g of the C9 to C10 aromatic range (duplicate). These were also the highest detected concentrations of these fractions. Other detections include 6.4 μ g/g of the C9 to C12 aliphatic range and 13 μ g/g of the C9 to C10 aromatic range in the 0-foot sample from 57S-98-08X. All other detections were below 5 μ g/g for the C9 to C12 aliphatic range. The C9 and C10 aromatic and C5 to C8 aliphatic ranges were not detected in any of the other samples.

Nine of the 10 samples analyzed were shown to contain detectable levels of EPH fractions. The 2-foot bgs sample from 57S-98-03X contained the highest levels of the C19 to C36 aliphatic and C11 to C22 aromatic ranges, 3,300 μ g/g and 990 μ g/g, respectively. The C9 to C18 aliphatic range was also detected in this sample at 110 μ g/g. Sample location 57S-98-07X contained 2,100 μ g/g of C19 to C36 aliphatics and 590 μ g/g (duplicate) of the C11 to C22 aromatics in the 0-foot sample. The C9 to C18 aliphatic range was below detectable levels in this sample. The 1-foot bgs sample from 57S-98-07X contained 1,600 μ g/g of the C11 to C22 aromatic range. Other locations containing elevated levels of EPH fractions include 57S-98-02X at 0 feet, 57S-98-04X at 1-foot bgs, 57S-98-05X at 3 feet bgs, and 57S-98-06X at 1-foot bgs. The EPH analysis yielded far fewer exceedances of MCP standards than did the TPHC values. Furthermore, the exceedances that were observed for the EPH fractions were of a much smaller magnitude than the TPHC exceedances at the same locations.

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Area 3

RI Test Pit Soil Sampling Off-Site Analytical Results. A total of five soil samples were collected from the Area 3 test pits 57E-95-24X, 57E-96-28X, 57E-96-29X, 57E-96-30X and 57E-96-31X. Soil samples were selected for off-site analysis based upon visual evidence, PID screening, and on-site analytical results. Samples were collected from depths ranging from 4 to 11 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC as well as petroleum fingerprinting in 1996. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganic analytes detected in exceedance of established background concentrations consist of antimony, cadmium, calcium, copper, lead, sodium and zinc. Sodium was in excess of background in all of the samples. The majority of the remaining exceedances occurred in the 4 feet bgs sample from 57E-95-24X.

Ethylbenzene, xylenes, and / or PCE were detected in three of the soil samples from Area 3 test pits. The identified laboratory contaminants 2-hexanone and trichlorofluoromethane (freon) were also detected in the soil samples. PCE was observed at 0.0094 μ g/g in the 10 feet bgs sample from 57E-96-28X and 0.0018 μ g/g in the 4 feet bgs sample from 57E-95-24X. Ethylbenzene and xylenes were detected in the 10 feet bgs sample from 57E-96-28X at 0.0042 μ g/g and 0.066 μ g/g respectively. The 6 feet bgs sample from 57E-96-30X was shown to contain 0.13 μ g/g of xylenes.

SVOC compounds were detected in all four of the soil samples collected from the test pits excavated in 1996 (57E-96-28X through 57E-96-31X). The bulk of the detections occurred in the 10 feet bgs sample from 57E-96-28X. Detected SVOC analytes consist of 1,2,4-trichlorobenzene at 0.5 μ g/g, 1,2-DCB at 6 μ g/g, 1,4-DCB at 4 μ g/g, 2-methylnaphthalene at 0.4 μ g/g, fluoranthene at 1 μ g/g, fluorene at 0.3 μ g/g, chrysene at 1 μ g/g, naphthalene at 2 μ g/g, phenanthrene at 0.4 μ g/g, and pyrene at 3 μ g/g.

The pesticide Aldrin was detected in the 4 feet bgs sample from 57E-95-24X at 0.0255 $\mu g/g$. Chlordane-alpha was found in 57E-96-28X at 0.0103 $\mu g/g$. In addition, chlordane-alpha and heptachlor epoxide were detected in 57E-96-31X at 0.068 and 0.00691 $\mu g/g$ respectively.

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PCBs were detected in three of the test pit soil samples. The highest observed concentration of PCBs, 3.6 μ g/g of Aroclor-1248 and 10 μ g/g of Aroclor-1260, was found in 57E-95-24X at 4 feet bgs. 1.7 μ g/g of Aroclor-1260 was also found in the 10 feet bgs sample from 57E-96-28X.

TPHC was detected in all of the Area 3 test pit soil samples at concentrations ranging between 64,900 μ g/g at 57E-95-24X and 262 μ g/g at 57E-96-29X. Petroleum fingerprinting performed on samples collected in 1996 showed that all samples were below detection limit for the gasoline, diesel, and aviation gas patterns. Field analytical results for TPHC are contoured and provided in Figure 7-3.

RI Soil Boring Off-Site Analytical Results. Eleven soil samples were collected for offsite analysis from five soil borings at AOC 57 Area 3 (57B-96-07X through 57B-96-11X). Soil samples were collected from the soil borings to confirm field analytical results and delineate horizontal and vertical distribution of contaminants. Samples were collected from depths ranging from the 0 to 10 feet bgs and analyzed at the off-site laboratory for PAL VOCs, SVOCs, inorganics, pesticides/PCBs, and TPHC as well as petroleum fingerprinting in 1996. Off-site laboratory analytical results for the subsurface soils are provided in Table 7-12.

Inorganics analyses indicated that arsenic, barium, calcium, cadmium, copper, lead, manganese, silver, sodium, and zinc were present in concentrations that exceeded established background concentrations for Devens soils. Sodium was detected in excess of background concentrations in every sample. Inorganic concentrations in soils do not appear to be related to sample depth. The greatest number of reported exceedances were found in the surficial sample from 57B-96-07X.

Analysis for VOCs indicated that six of the samples contained toluene. The majority of the toluene concentrations are consistent with it being reported as a potential laboratory or sampling contaminant. However, the highest detected concentration, 0.31 μ g/g at 5 feet bgs in 57B-96-07X, is substantiated by a detection of ethylbenzene at 1.2 μ g/g and xylenes at 22 μ g/g. PCE was detected in one sample, the surficial sample from 57B-96-07X at a concentration of 0.0057 μ g/g.

SVOC compounds were detected in two soil boring samples from Area 3. The 5-foot bgs sample from 57B-96-07X contained 31.3 μ g/g of total SVOCs including 8 μ g/g of 1,2-

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DCB, 2 μ g/g of 1,4-DCB, 9 μ g/g of 2-methylnaphthalene, and 9 μ g/g of naphthalene. The surficial sample from 57B-96-09X contained 0.448 μ g/g of total SVOCs.

Pesticides were detected in two of the soil boring samples. The surficial sample from 57B-96-09X was shown to contain 4,4'-DDE and 4,4'-DDT at concentrations of 0.0081 and 0.0121 μ g/g respectively. The five feet bgs sample from 57B-96-11X contained 0.017 μ g/g of 4,4'-DDE.

Three of the samples contained PCBs. The surficial sample from 57B-96-07X had detections of Aroclor-1240 and Aroclor-1260 at 3.4 and 8 μ g/g respectively. The 5-foot bgs sample from the same boring contained 2.6 μ g/g of Aroclor-1242 and 6.1 μ g/g of Aroclor-1260. Aroclor-1260 was also detected at a concentration of 7.4 μ g/g at 5 feet bgs in boring 57B-96-11X.

Five samples were shown to contain measurable levels of TPHC. Three of these samples contained levels in excess of 100 μ g/g; the surficial sample from 57B-96-07X contained 41,400 μ g/g, the 5 feet bgs sample from the same boring contained 31,600 μ g/g, and the 5 feet bgs sample from 57B-96-11X was found to contain 4,250 μ g/g. Petroleum fingerprinting of the soil samples indicated that the TPHC contamination was consistent with a motor oil pattern.

1998 Surface and Subsurface Soil Sampling Off-Site Analytical Results.

Three samples from the 1998 soil sampling activities were selected for off-site analysis, 57S-98-13X at 1-foot bgs, 57S-98-14X at 1-foot bgs, and 57S-98-15X at 3 feet bgs (Figure 7-3). Samples were analyzed at the off-site laboratory for EPH/VPH, TPHC, PAL VOCs, PAL SVOCs, PAL pesticides/PCBs, and select PAL inorganics. Samples were selected for off-site analysis based upon visual evidence, PID screening, and field analytical results. Off-site and on-site analytical results for the 1998 soil sampling are provided in Table 7-13.

Arsenic was the only inorganic analyte detected at levels in excess of established Devens background concentrations. The highest detected concentration was 28.2 μ g/g in the 3-foot bgs sample from 57S-98-15X.

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Five VOC compounds were detected in the 1998 Area 3 soil samples. The 1-foot bgs sample from 57S-98-13X contained 0.012 μ g/g of chlorobenzene and 0.0042 μ g/g of TCE. 57S-98-15X at 3 feet bgs contained 0.013 μ g/g of 1,1,1-TCA, 0.0013 μ g/g of toluene, and 0.0041 μ g/g of xylenes. There were no VOC detections in 57S-98-14X.

SVOC compounds were detected in two soil samples. The majority of the detections were found in 57S-98-13X at 1-foot bgs which contained 1,2-DCB at 0.35 μ g/g, 1,4-DCB at 0.48 μ g/g, flouranthene at 0.13 μ g/g, phenanthrene at 0.067 μ g/g, and pyrene at 0.096 μ g/g. The common laboratory contaminant bis(2-ethylhexyl)phthalate was the only SVOC detected in 57S-98-15X 14 μ g/g.

Low levels of pesticides were detected in two of the three soil samples. 57S-98-13X at 1-foot bgs contained 0.0028 μ g/g of chlordane alpha, 0.0028 μ g/g of chlordane gamma, and 0.0234 μ g/g of 4,4'-DDD. The only pesticide detected in 57S-98-14X was 4,4'-DDT at 0.0248 μ g/g. No pesticides were detected in 57S-98-15X.

57S-98-14X at 1-foot bgs contained the only detection of PCBs, 0.474 μ g/g of Aroclor-1260 at 1-foot bgs.

Two of the three soil samples submitted for off-site analysis contained detectable levels of TPHC. 57S-98-13X had 951 μ g/g at 1-foot bgs and 57S-98-14X contained 895 μ g/g at 1-foot bgs. These results were slightly lower than the on-site TPHC analysis but were consistent with TPHC distributions determined by earlier investigations.

The soil samples were also analyzed by EPH/VPH, which is generally recognized as a more reliable means of determining concentrations of petroleum hydrocarbons. TPHC and EPH/VPH values for Area 3 are presented in Table 7-13 and Figure 7-4.

The only detection of a VPH carbon range was 3.7 μ g/g of C9 to C12 aliphatics.

Two of the three soil samples analyzed were shown to contain detectable levels of EPH fractions. The 1-foot bgs sample from 57S-98-13X contained the C19 to C36 aliphatic and C11 to C22 aromatic ranges, 180 μ g/g and 60 μ g/g respectively. The 1-foot bgs sample from 57S-98-14X also contained the C19 to C36 and C11 to C22 ranges at 150 μ g/g and 75 μ g/g, respectively. There were no EPH detections in 57S-98-15X. EPH concentrations for these samples were much lower than the respective TPHC concentrations with respect to

MCP standards suggesting that the TPHC analysis was artificially high due to organic content in the soil or potential biogenic TPHC sources.

7.2.2.3 Summary of Soil Impacts.

Area 2

Soil contamination at Area 2 can be divided into two types, surficial contaminants, primarily petroleum hydrocarbons, in the northern portion of the site and higher levels of VOCs, SVOCs, PCBs, and petroleum hydrocarbons in surface and subsurface soils along the southern portion of the soil removal excavation.

Elevated levels of TPHC were observed in the surficial sample from soil boring 57B-95-02X located in the flat, northern portion of the site above the treeline. Other detected contaminants included low levels of SVOCs, pesticides, and PCBs.

The most significant contamination encountered during the 1995 RI efforts was located around the southern portion of the soil removal excavation from the test pit 57E-95-07X to 57E-95-12X at depths ranging from the ground surface to the water table at 4 to 5 feet bgs. Detected VOCs include TEX, 1,2-DCE (cis and trans), TCE, and PCE. The primary SVOCs encountered were naphthalene and methylnaphthalene. Elevated levels of pesticides and PCBs were also observed. High levels of TPHC were coincident with the VOC detections.

The 1998 soil sampling aided in defining the southern extent of the petroleum hydrocarbon contamination south of the Removal Action Excavation. TPHC and/or EPH results from 57S-98-04X, 57S-98-08X, 57S-98-09X, and 57S-9810X all showed decreased concentrations compared to upgradient explorations. Elevated EPH concentrations were observed in the area to the southwest of the Removal Action and at 57S-98-06X.

A comparison of 1998 EPH results and TPHC results showed that EPH results were much lower than TPHC results from the same sample with respect to the MCP screening values. This suggests that the TPHC data may be artificially high due to interference with organic material in the soils or potential biogenic sources.

Elevated levels of arsenic were detected in surficial samples coincident with the petroleum hydrocarbon contamination.

Data gathered during the RI as well as previous investigations suggests that the contaminated soils are due to the historical disposal of vehicle maintenance related wastes. Contaminant distributions indicate that the disposal occurred along the break in slope above the floodplain. Contaminants in surficial soils then percolated/leached into subsurface soils and groundwater where they were transported hydrogeologically downgradient and resorbed to subsurface soils. Contaminants to the south and southeast of the removal action excavation do not appear to be migrating toward the wetland. Contaminant distributions do show that petroleum hydrocarbons and chlorinated VOCs do appear to have migrated toward the wetland southwest of the excavation.

Area 3

Soil sampling of test pits, TerraProbesSM, and soil borings at Area 3 indicated that concentrations of soil contaminants were highest in the area bounded by test pit 57E-95-24X to the north and the soil boring 57B-96-07X to the south. A historic disposal site located from the surface to approximately 5 feet bgs was defined by test pits 57E-96-28X through 57E-96-31X. Advective transport and sorption appears to have aided in the southerly migration of soil contamination.

The most significant observed soil contaminants included the SVOCs naphthalene, 1,2-DCB, and 1,4-DCB. Elevated levels of PCBs in soil were encountered in proximity to the source area.

Elevated levels of TPHCs were observed coincident with the SVOC contamination.

Soil sampling performed in 1998 further defined the downgradient extent of the soil contamination. Downgradient soils showed decreasing levels of petroleum hydrocarbons, VOCs, SVOCs, and arsenic.

A comparison of EPH and TPHC results showed that EPH values were significantly lower than TPHC results from the same sample. This suggests that the TPHC data may be artificially high due to interference with organic material in the soils or potential biogenic sources.

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7.2.3 AOC 57 RI Groundwater

The following discussion of groundwater sampling includes field analytical results of water samples collected from TerraProbeSM borings and monitoring well borings as well as the off-site laboratory analytical results for the three rounds of RI groundwater sampling (two rounds at Area 2 and one round at Area 3). Groundwater quality will be discussed separately for Area 2 and Area 3.

7.2.3.1 RI Field Analytical Groundwater Results.

Area 2

During the 1995 investigation, a total of eleven groundwater samples were collected from six monitoring well borings and 5 soil borings at Area 2 and analyzed in the field for BTEX, select VOCs, and GRO (Table 5-1). Data from the monitoring well and soil boring groundwater samples were used to delineate horizontal contaminant distribution and confirm placement of monitoring well locations. In addition, one groundwater sample was collected in 1998 from the piezometer 57P-98-02X. Field analytical results are provided in Tables 7-14 and 7-16.

The only detection was PCE at a concentration of 2.5 μ g/L at the water table in the monitoring well boring 57M-95-07X.

Area 3

As part of the 1995 and 1996 investigations, thirty-three groundwater samples were collected from TerraProbeSM points, monitoring well borings, and soil borings. All of the groundwater samples were analyzed in the field for BTEX, select VOCs, and GRO (1995 samples only). In addition, three groundwater samples were collected from the Area 3 piezometers and 57M-96-11X in 1998 and field analyzed for TPHC. Groundwater field screening analyses results are provided in Tables 7-14 and 7-16.

BTEX, chlorobenzene, PCE, and GRO were detected in groundwater samples collected from six TerraProbeSM points in 1995, 57R-95-01X through 57R-95-06X (Figure 5-9). The highest concentrations of BTEX compounds were found in the groundwater sample from
57R-95-05X including 110 μ g/L of benzene, 240 μ g/L of toluene, 410 μ g/L of ethylbenzene, and 1,650 μ g/L of xylenes. This sample also contained 43,000 μ g/L of GRO, which was in excess of the detection limit. PCE was detected in two samples, 2.1 μ g/L in 57R-95-02X and 2.5 μ g/L in 57R-95-04X. Based on these results, monitoring well 57M-95-03X was installed at the location of 57R-95-03X.

Field analysis of groundwater samples collected in 1996 showed concentrations of TEX, 1,2-DCB, 1,4-DCB, 1,1-DCE, PCE, and naphthalene. Figure 7-5 shows groundwater contaminant detections for the 1996 sampling event. Notable detections include $3.2 \mu g/L$ of PCE at 57B-96-08X, 110 $\mu g/L$ of 1,2-DCB and 130 $\mu g/L$ of naphthalene in 57R-96-19X, and 95 $\mu g/L$ of 1,1-DCE in 57B-96-09X.

TPHC was not detected in the 1998 samples.

7.2.3.2 RI Groundwater Off-Site Laboratory Analytical Sample Results.

Area 2

As part of the RI field investigation HLA installed nine monitoring wells at Area 2 in 1995 (57M-95-01X, 57M-95-02X, 57M-95-04A, 57M-95-04B, 57M-95-05X, 57M-95-06X, 57M-95-07X, 57M-95-08A, and 57M-96-08B) to supplement the two existing Group 3 monitoring wells (G3M-92-02X and G3M-92-07X) (Figure 5-8). Two rounds of groundwater sampling were conducted on all of the monitoring wells. Groundwater samples were analyzed for PAL VOCs, SVOCs, total and filtered PAL inorganics, pesticides/PCBs, TPHC, TDS, and water quality parameters. Analytical results for the Round 1 and Round 2 sampling events are provided in Table 7-15.

Several inorganic analytes were detected above the calculated Devens background concentrations in groundwater. Arsenic, barium, calcium, copper, lead, manganese, potassium, sodium, and zinc were detected above background in the unfiltered samples. The filtered samples contained barium, lead, manganese, potassium, and sodium at levels in excess of the established background concentrations. The greatest numbers of background exceedances were observed in the Round 1 unfiltered samples from 57M-95-01X and 57M-95-04A. The Round 2 samples from these wells showed only one exceedance, sodium in 57M-95-01X. The Round 2 unfiltered samples also showed a dramatic decrease in total suspended solids from Round 1.

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Several VOCs were detected in Round 1 and Round 2 groundwater samples. 1,1,1-TCA at 0.5 μ g/L, toluene at 0.63 μ g/L, 0.56 μ g/L of TCE, and 356 μ g/L of TPHC were detected in the Round 1 sample from 57M-95-01X. The Round 2 sample contained only toluene at 1.2 μ g/L. The Round 2 sample from the other upgradient wells, 57M-95-02X and G3M-92-07X, contained 1.6 μ g/L and 0.89 μ g/L, respectively, of toluene.

Groundwater contamination in the vicinity of the soil removal excavation contained lower concentrations of toluene than the upgradient samples. However, Round 1 and Round 2 samples from the monitoring wells 57M-95-04A, 57M-95-07X, and 57M-95-08B contained quantities of chlorinated solvents. 1,2-DCE (cis and trans), TCE, and PCE were detected in Round 1 and Round 2 samples from 57M-95-04A. This well also contained the highest observed concentrations of these compounds; 3.6 μ g/L of 1,2-DCE (cis and trans) in the Round 1 sample, 1.9 μ g/L of TCE in the Round 2 sample, and 16 μ g/L of PCE in the Round 2 sample. Round 1 and Round 2 VOC detection data are shown in Figure 7-6.

Diethyl phthalate and bis(2-ethylhexyl) phthalate were the only SVOCs detected in the Round 1 and 2 groundwater samples from Area 2. Both of these compounds have been identified as common laboratory and / or sampling contaminants. Diethyl phthalate was detected in both Round 1 and Round 2 samples, at 2.3 μ g/L and 3.2 μ g/L respectively, in only one well, 57M-95-02X. Bis(2-ethylhexyl) phthalate was detected in Round 1 and Round 2 samples from both 57M-95-04B and 57M-95-08B. In both of these wells the Round 2 samples were orders of magnitude greater than the Round 1 samples, 5 μ g/L for the Round 1 sample and 400 μ g/L for the Round 2 in 57M-95-04B and 6.9 μ g/L and 300 μ g/L in 57M-95-08B.

Endosulfan I was the only pesticide detected in Area 2 groundwater. The Round 1 sample from 57M-95-06X contained $0.0271 \mu g/L$.

No PCBs were detected in Area 2 groundwater.

TPHC was detected in one sample, 57M-95-01X during Round 1 was reported to contain 356 μ g/L. TPHC concentrations in this well for Round 2 were below detection limits. As was noted in the inorganics discussion the total suspended solids in this well decreased from 23,200 μ g/L in Round 1 to 5,000 μ g/L in Round 2.

One groundwater sample was collected in 1998 from the piezometer 57P-98-02X and submitted for off-site analysis for VOCs, SVOCs, select inorganics, pesticides/PCBs, and EPH/VPH.

The inorganics, arsenic, lead, and manganese were detected at levels in excess of established Devens background concentrations. The manganese data was flagged as rejected for QC reasons. Arsenic was detected at 54.5 μ g/g and lead at 16 μ g/L in the unfiltered samples. The filtered sample contained 73 μ g/L of arsenic and 4.4 μ g/L of manganese.

Three VOCs were detected in the sample, 1,2-DCE at 13 μ g/L; TCE at 0.71 μ g/L; and toluene at 0.54 μ g/L.

The lone SVOC detected was bis(2-ethylhexyl)phthalate at 6.4 μ g/L.

No pesticides or PCBs were detected.

No EPH or VPH ranges were detected.

Area 3

Groundwater samples were collected using low-flow sampling protocols in November of 1996 from seven monitoring wells at AOC 57 Area 3 (G3M-92-07X, 57M-95-03X, 57M-96-09X, 57M-96-10X, 57M-96-11X, 57M-96-12X, and 57M-96-13X). Two rounds of samples were collected from G3M-92-07X and 57M-95-03X in conjunction with the Area 2 groundwater sampling which was performed using conventional purge and bail sampling in the fall of 1995 and winter of 1996. Only the low flow sample data from G3M-92-07X and 57M-95-03X will be incorporated into the Area 3 assessment although all data is provided in Table 7-15. Figure 7-7 shows all analyte detections.

Arsenic, barium, cadmium, calcium, iron, manganese, potassium, sodium, sodium, and zinc were identified at concentrations in excess of established Devens background concentrations. Two of these compounds were detected at levels in excess of MCLs, cadmium at 8.67 μ g/L in 57M-95-03X and arsenic at 170 μ g/L in the normal and duplicate samples from 57M-96-11X.

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VOCs were detected in 57M-95-03X, 57M-96-11X, 57M-96-12X, and 57M-96-13X. Toluene was found in all of these samples with a maximum concentration of 19 μ g/L in 57M-95-03X. Toluene, at 1.1 μ g/L, was the only VOC detected in 57M-96-12X. 57M-96-13X contained toluene at 2.9 μ g/L, ethylbenzene at 2.8 μ g/L, and the only detection of styrene with 8 μ g/L. Chlorinated solvents comprised the majority of the detections in 57M-95-03X and 57M-96-11X. 57M-95-03X contained 4.5 μ g/L of carbon tetrachloride, 10 μ g/L of chloroform, 2.9 μ g/L of dichloromethane, 0.59 μ g/L of TCE, 2.6 μ g/L of PCE, as well as 46 μ g/L of ethylbenzene and 200 μ g/L of xylenes. 57M-96-11X contained 0.89 μ g/L of 1,2-DCE (cis and trans), 1.1 μ g/L of TCE, and 4.8 μ g/L of PCE. This sample also contained 0.86 μ g/L of toluene, 4.6 μ g/L of ethylbenzene, and 6.8 μ g/L of xylenes.

The majority of SVOC detections occurred at 57M-95-03X and 57M-96-11X. 57M-95-03X, located immediately downgradient of the identified source area contained 9.8 μ g/L of 1,2-DCB, 5.6 μ g/L of 1,4-DCB, 4.4 μ g/L of 2-methylnaphthalene, 1.5 μ g/L of 4-methylphenol, and 20 μ g/L of naphthalene. The duplicate sample from 57M-96-11X, the furthestmost downgradient well contained 3.4 μ g/L of 1,2-DCB, 3.3 μ g/L of naphthalene, and 6.7 μ g/L of bis(2-ethylhexyl) phthalate. Other SVOC detections include 5 μ g/L of methylphenol in 57M-96-13X and 12 μ g/L of bis(2-ethylhexyl) phthalate in the sample from the upgradient well G3M-92-07X.

No pesticides, PCBs, or TPHC were detected in Area 3 groundwater.

Additional groundwater sampling was performed at Area 3 in May of 1998. Samples were collected from the piezometers 57P-98-03X and 57P-98-04X, as well as the monitoring well 57M-96-11X. The groundwater samples were submitted for off-site analysis for VOCs, SVOCs, select inorganics, pesticides/PCBs, and TPHC.

The inorganic analytes arsenic, barium, copper, lead, and manganese were detected in the unfiltered samples at levels in excess of established Devens background concentrations. Arsenic was the only analyte to exceed background concentrations in the filtered sample. The highest concentration of arsenic detected in an unfiltered sample was 84.4 in a duplicate sample collected from 57M-96-11X. The filtered samples collected from 57M-96-11X contained higher levels of arsenic, 138 μ g/L in the duplicate sample. The normal sample from 57M-96-11X contained comparable arsenic concentrations, 84.4 μ g/L in the unfiltered sample and 133 μ g/L in the filtered sample. Total suspended solids in this sample were 2,120,000 μ g/L. Arsenic levels in the piezometers were significantly lower,

13.4 μ g/L and 20.9 μ g/L in the unfiltered and filtered samples collected from 57P-98-03X and 7.7 μ g/L and 12.7 μ g/L in the unfiltered and filtered samples collected from 57P-98-04X. There is no known explanation for the uniform increase in arsenic concentrations from the unfiltered to the filtered samples. All other inorganic analyte concentrations decreased from the unfiltered to the filtered samples.

The majority of VOC detections occurred in 57M-96-11X. PCE was detected at 5.5 μ g/L, TCE at 3.8 μ g/L, ethylbenzene at 20 μ g/L, and xylenes at 5.8 μ g/L. Two VOCs were detected in 57P-98-03X, ethylbenzene at 3.2 μ g/L, and xylenes at 5.7 μ g/L. Chlorobenzene at 0.88 μ g/L was the only VOC detected in 57P-98-04X.

Five SVOCs were detected in the 1998 Area 3 groundwater samples. The most detections occurred in 57P-98-03X which contained bis(2-ethylhexyl)phthalate at 52 μ g/L, 1,2-DCB at 4.9 μ g/L, 2-methylnaphthalene at 2 μ g/L, and naphthalene at 13 μ g/L. 57M-96-11X contained detectable levels of three SVOC compounds, 1,2-DCB at 6.4 μ g/L, 1,4-DCB at 2.7 μ g/L, and naphthalene at 6.2 μ g/L.

No pesticides or PCBs were detected in the 1998 Area 3 groundwater samples.

No EPH fractions were detected.

All three VPH carbon ranges were detected in the sample collected from 57M-96-11X. The C5 and C8 aliphatic range was detected at 91 μ g/L, the C9 to C12 aliphatic range at 75 μ g/L, and the C9 to C10 aromatic range at 250 μ g/L (duplicate sample). The highest concentration of aromatics, 310 μ g/L, was detected in 57P-98-03X. This was the only VPH fraction detected in this sample.

7.2.3.3 Summary of Groundwater Impacts

Area 2

Identified Area 2 groundwater contaminants include 1,2-DCE, TCE, PCE, and toluene. As with the soil contamination, the contamination is localized around the southern perimeter of the soil removal excavation. In addition, PCE was detected in both Rounds 1 and 2 at 57M-95-07X located approximately 140 feet west of the excavation.

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No SVOCs, other than probable laboratory contaminants, were identified in Area 2 groundwater.

Endosulfan in the Round 1 sample from 57M-95-06X was the only pesticide detected in groundwater.

No PCBs were detected in Area 2 groundwater.

The only Area 2 TPHC detection, 356 μ g/L, occurred in the Round 1 sample from the upgradient well 57M-95-01X.

Area 3

Area 3 groundwater contamination occurs primarily from the source area located immediately north of 57M-95-03X to the furthestmost downgradient monitoring well 57M-96-11X. Contaminants observed in this area include inorganics, VOCs and SVOCs.

Elevated levels of cadmium and arsenic were observed in 57M-95-03X and 57M-96-11X, respectively. Arsenic concentrations decreased dramatically in the piezometers located downgradient of 57P-96-11X.

Detected VOCs include TEX, TCE, and PCE. Additional VOCs detected in the source area well 57M-95-03X include carbon tetrachloride and chloroform. Additional VOCs detected at the downgradient well 57M-95-11X consist of the chlorinated organic degradation product 1,2-DCE. The downgradient piezometers 57P-98-03X and 57P-98-04X contain only low levels of ethylbenzene and chlorobenzene.

SVOCs are significant groundwater contaminants at Area 3. SVOCs detected consist of 1,2-DCB, 1,4-DCB, and naphthalene. These SVOCs were detected at both the source area well 57M-95-03X and the downgradient well 57M-96-11X and piezometer 57P-98-03X.

No pesticides, PCBs, or TPHC were detected in Area 3 off-site groundwater samples.

7.2.4 RI Sediment

RI sediment sampling was conducted at Area 2 in 1995 and 1998 and at Area 3 in 1998.

The 1995 sampling consisted of the collection of fourteen sediment samples, including a duplicate sample, from eight sample locations (57D-95-03X through 57D-95-10X) in Cold Spring Brook and its associated wetlands in the vicinity of AOC 57 Area 2 (Figure 5-8). Two sediment samples, a surficial and one from 2 feet bgs, were collected from 57D-95-03X through 57D-95-07X. Surficial sediment only was collected at 57D-95-08X through 57D-95-10X. Sediment samples were analyzed for select PAL VOCs, SVOCs, inorganics, pesticides, PCBs, TOC, TPHC, and petroleum fingerprinting. Results of the off-site sediment sample analyses are presented in Table 7-17. In 1998 three additional surface water and sediment pairs were collected at Area 2 (57D/W-98-01X through 57D/W-98-03X). Also in 1998 five surface water and sediment pairs were collected from the Area 3 wetlands (57D/W-98-04X through 57D/W-98-08X, Figure 5-9). The 1998 samples were analyzed for PAL VOCs, SVOCs, select inorganics, pesticides, PCBs, EPH/VPH, and TPHC (sediment only).

Area 2 Sediment. Background concentrations for inorganics in sediment have not been established for the Devens area; therefore, inorganic concentrations in 1995 sediment samples 57D-95-03X through 57D-95-10X were compared against established background concentrations for Devens soils. Exceedances of background concentrations were noted for arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, sodium, vanadium, and zinc. The surficial sediment samples had far more exceedances of background concentrations than the deeper sediment samples. There were no apparent correlations between sample locations and the number of background exceedances. However, the greatest number of maximum observed concentrations occurred at the upstream sample 57D-95-03X. Maximum concentrations and their respective sample locations are as follows: arsenic, 180 μ g/g at 57D-95-03X; barium, 159 µg/g at 57D-95-07X; beryllium, 2.8 µg/g at 57D-95-04X (2 feet below surface); cadmium, 2.33 µg/g at 57D-95-05X; calcium, 18,400 µg/g at 57D-95-07X; chromium, 98.8 µg/g at 57D-5-05X (2 feet below surface); cobalt, 29.9 µg/g at 57D-95-03X; copper, 201 µg/g at 57D -95-04X (1 foot below surface); iron, 31,500 µg/g at 57D-95-03X; lead, 410 µg/g at 57D-95-04X (1 foot below surface); manganese, 3,940 µg/g at 57D-95-07X; mercury, 0.36 μg/g at 57D-95-06X; nickel, 46.8 μg/g at 57D-95-03X; selenium, 3.24 µg/g at 57D-95-03X; sodium, 3,610 µg/g at 57D-95-04X (1 foot below surface); vanadium, 46.4 µg/g at 57D-95-03X; and zinc, 468 µg/g at 57D-95-09X.

The 1998 samples contained three compounds that exceeded background concentrations. The sediment sample CSD-98-01X, located on the edge of the marsh on the upstream side

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G:Projects\USAEC\PROJECTS\S7RITEXT\final\S7finaltext.doc June 6, 2000 of the containment dike, contained 14.3 μ g/g of copper and 220 μ g/g of arsenic. This was the highest concentration of arsenic detected in Cold Spring Brook sediments. The other background exceedance occurred in 57D-98-02X, located on the edge of the marsh on the downstream side of the containment dike. This sample contained lead at 88.9 μ g/g. There were no background exceedances in the furthestmost downgradient sample 57D-98-03X.

The 1995 and 1998 sediment data are consistent with the results of the Lower Cold Spring Brook SI (ABB-ES, 1995) which concludes that inorganic concentrations tend to be highest in the upstream sample CSD-98-13X and Area 2 marsh samples CSD-98-14X, CSD-94-20X, and CSD-94-35X. The downstream samples CSD-94-17X, SSD-93-92G, and CSD-94-19X generally contained lower inorganic concentrations than the upstream samples. The lowest concentrations were in CSD-94-19X, the most downstream of the Lower Cold Spring Brook SI samples collected for AOC 57.

The inorganic results show that elevated levels of arsenic are present at the edge of the Area 2 marsh on the upstream side of the containment dike. However, arsenic concentrations in sediment collected from the marsh between Area 2 and the stream channel (e.g., CSD-94-14X, CSD-94-20X, CSD-94-35X, 57D-95-04X, and 57D-95-05X, Figure 5-6) showed much lower arsenic concentrations, all below the MCP S-1/GW-1 standard. This indicates that arsenic contamination in sediment within the stream channel is attributed to upstream sources or conditions as evidenced in the upgradient samples G3D-92-01X and 57D-95-03X. Results of the Lower Cold Spring Brook SI and RI sampling showed that arsenic concentrations in sediment decrease in the downstream direction (Figure 7-8). Historical photographs show that between 1920 and 1960, apple orchards were located adjacent to the south side of Cold Spring Brook southwest (upstream) of Area 2. The orchards and railroad tracks, which cross Barnum Road, are a potential source of the observed upstream arsenic contamination.

The common laboratory contaminants acetone, dichloromethane (methylene chloride), toluene, and trichlorofluoromethane (freon) were detected in several of the 1995 sediment samples. Toluene was detected in six of the sediment samples and is consistent with soil and groundwater contamination at AOC 57 Area 2. One of the toluene detections occurred at an upstream sampling location, 0.0028 μ g/g in the 2 feet below surface sample from 57D-95-03X. The maximum concentration observed in sediments of 0.02 μ g/g in the 1 foot below surface sample from 57D-95-04X, located in the marsh area upstream of the containment dike. PCE and chlorobenzene were detected in only one of the 1995 RI

sediment samples. The 2 feet below surface sample from the upstream location 57D-95-03X contained 0.0046 μ g/g of PCE and 0.0016 μ g/g of chlorobenzene.

The 1998 sediment samples from Area 2 contained two VOC compounds, PCE and TCE. 57D-98-01X, located on the upstream side of the containment dike contained 0.078 μ g/g of PCE. 57D-98-02X, located on the downstream side of the containment dike contained 0.01 μ g/g of PCE and 0.027 μ g/g of TCE. There were no VOC detections in 57D-98-03X. The 1995 and 1998 data show that AOC 57 Area 2 is contributing small amounts of chlorinated VOCs (PCE and TCE) to near shore sediments. PCE and TCE were not detected in stream channel sediments. The data also suggests that Area 2 may be a source of toluene contamination in sediments although toluene was detected in upstream sediments.

The SVOCs benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected in 1995 RI sediment samples. Chrysene was found in only one of the samples, the 2 feet below surface sample from the downstream location 57D-95-07X at 0.46 μ g/g, while the rest of the compounds were found in both upstream and downstream samples. The highest concentrations of total SVOCs were observed in the duplicate surficial sample from the upstream location 57D-95-03X and the surficial sample from 57D-95-07X, located downstream from the containment dike. Respective SVOC concentrations were 19 μ g/g at 57D-95-03X and 18 μ g/g in 57D-95-07X.

Benzo(k)flouranthene, chrysene, flouranthene, phenanthrene, and pyrene were detected in the 1998 sediment samples. The highest total concentration of SVOCs as well as the highest individual concentrations were found in 57D-98-02X which contained 6.65 μ g/g of total SVOCs. 57D-98-01X had 3.05 μ g/g of total SVOCs and 57D-98-03X contained 2.20 μ g/g. These data suggests that Area 2 is contributing small amounts of SVOCs to the wetland. However, the 1995 RI sampling and the Lower Cold Spring Brook SI showed that much higher concentrations were detected in the upstream samples 57D-95-03X and CSD-94-13X indicating an upstream source.

Ten of the 1995 RI sediment samples were found to contain pesticides. The surficial sediment samples contained higher concentrations than the deeper sediment samples. The highest concentrations of total pesticides as well as the maximum observed concentrations of individual analytes were observed in the upstream samples. The upstream surficial samples from locations 57D-95-08X and 57D-95-03X both contained 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT at total concentrations of 0.79 μ g/g and 1.165 μ g/g, respectively. The deeper

sample (2 feet below surface) at 57D-95-03X contained 4,4'-DDD and 4,4'-DDE at a total concentration of 0.0719 μ g/g. Surficial samples from the area immediately upstream of the containment dike had concentrations of total pesticides of 0.7081 (57D-95-05X) and 0.678 μ g/g (57D-95-06X). The only detection of the pesticide dieldrin, at 0.0183 μ g/g, was found in the surficial sample from 57D-95-05X. Sample locations downstream of the containment dike containment to the smallest concentrations of total pesticides.

Pesticides were detected in two of the three 1998 sediment samples. 57D-98-02X contained 0.091 μ g/g of 4,4'-DDD and 57D-98-03X contained 0.0418 μ g/g of 4,4'-DDD and 0.046 μ g/g of dieldrin. No pesticides were detected on the upstream side of the containment dike at 57D-98-01X. As with many of the previous analytes the highest concentrations have been found at the upstream locations and not adjacent to AOC 57 Area 2.

PCBs were found in only one 1995 RI sediment sample. The surficial sediment sample from 57D-95-05X was found to contain 0.301 μ g/g of Aroclor-1260.

None of the 1998 sediment samples contained PCBs.

TPHC concentrations in 1995 RI sediment samples from Cold Spring Brook ranged between 106 μ g/g in the deep sediment sample from 57D-95-07X and 3170 μ g/g in the surficial sample from 57D-95-05X. The highest observed TPHC concentrations were observed in the surficial samples located immediately upstream of the containment dike adjacent to AOC 57 Area 2. Petroleum fingerprinting of the sediment samples indicated that the upstream and downstream samples were comprised of both the diesel and gasoline patterns while the samples collected adjacent to Area 2 were predominately of the diesel pattern.

TPHC concentrations in the samples collected in 1998 ranged between 103 μ g/g in 57D-98-01X and 452 μ g/g in 57D-98-02X. EPH/VPH carbon ranges for these samples were all below detection levels (Figure 7-2).

Area 3 Sediment. Five sediment samples were collected from the wetlands immediately south of AOC 57 Area 3 in 1998 (Figure 5-9 and 7-4). 1998 sediment sample locations are approximately 350 feet northwest of the Cold Spring Brook Stream channel. Inorganics analysis of these samples showed that arsenic, barium, lead, manganese, and zinc were present at levels in excess of established Devens soil background levels. The greatest

number of exceedances were found in 57D-98-05X which contained arsenic at 37.1 μ g/g, lead at 64.6 μ g/g, and zinc at 90.8 μ g/g. Barium at 59.8 μ g/g and copper at 459 μ g/g were above background levels in 57D-98-04X. Arsenic at 37 μ g/g was the only background exceedance in 57D-98-06X.

Several sediment samples were collected from the portion of Cold Spring Brook located hydrogeologically downgradient from Area 3 as part of the Lower Cold Spring Brook SI. These samples include CSD-94-16X and CSD-94-18X. CSD-94-26X represents conditions downstream of this area and G3D-92-02X, CSD-94-19X, and the 1995 RI samples 57D-95-07X and 57D-95-10X represent conditions upstream. A review of inorganic data from these locations indicates that Area 3 is not impacting sediment quality in Cold Spring Brook which is located approximately 350 feet to the southeast. The Lower Cold Spring Brook SI stated that inorganics concentrations were generally higher in upstream samples than in the downstream samples. Arsenic concentrations in this area follow a general trend of decreasing from the upstream locations (e.g., G3D-92-02X, CSD-94-19X, 57D-95-07X and 57D-95-10X) to the downstream locations (CSD-94-26X and CSD-94-27X) (Figure 7-8). One of the further downstream samples, G3D-92-03X, did exhibit an elevated arsenic concentration of 95.2 μ g/g. This result is not corroborated by any sample results either immediately upstream or downstream.

The VOCs acetone, benzene, chlorobenzene, toluene, and xylene were detected in Area 3 sediment samples. Acetone was found in every sample at concentrations ranging between 0.21 and 0.057 μ g/g. 57D-98-08X had the most detections, 0.037 μ g/g of benzene, 0.0031 μ g/g of chlorobenzene, 0.0048 μ g/g of toluene, and 0.011 of xylenes. 57D-98-06X was found to contain 0.007 μ g/g of benzene, 0.013 μ g/g of chlorobenzene, and 0.0047 of toluene. 57D-98-05X contained low levels of chlorobenzene and toluene, 0.019 μ g/g and 0.0018 μ g/g respectively. There is no evidence that Area 3 VOCs are adversely impacting the wetlands or Cold Spring Brook sediments.

The SVOCs 1,2-DCB, 1,4-DCB, benzo(b)flouranthene, benzo(k)flouranthene, chrysene, flouranthene, naphthalene, phenanthrene, and pyrene were detected in Area 3 sediment samples. The highest concentration of total SVOCs was found in 57D-98-05X, 3.27 μ g/g. The SVOCs detected in sediment are consistent with those detected in source area and downgradient soils and groundwater. The SVOC concentrations decrease farther into the wetland, 57D-98-07X contained 1.86 μ g/g and 57D-98-08X contained 0.415 μ g/g.

The Lower Cold Spring Brook SI samples (Appendix E) collected from the portion of the brook downgradient of Area 3 (Bowers Brook area) showed that SVOCs decreased from the upstream samples to the downstream samples. Pyrene at 1 μ g/g was the only SVOC detected at CSD-94-18X and no SVOCs were detected in the downstream sample CSD-94-26X.

One pesticide was detected in Area 3 sediments. 4,4'-DDD was detected in 57D-98-05X at 0.048 μ g/g and in 57D-98-06X at 0.15 μ g/g. Pesticides were not detected in any other 1998 Area 3 sediment samples.

Of the samples included in the Lower Cold Spring Brook SI, only CSD-94-18X was analyzed for pesticides. 4,4'-DDD was found in this sample at 0.0498 μ g/g. This pesticide was also found in upstream samples near Area 2.

PCBs were detected in one of the Area 3 sediment samples. 57D-98-05X contained 0.84 $\mu g/g$ of aroclor 1260. PCBs were not detected in Lower Cold Spring Brook SI samples.

TPHC concentrations ranged between 3,540 μ g/g at 57D-98-05X and 109 μ g/g at 57D-98-08X. Besides 57D-98-05X, all other samples contained less than 250 μ g/g of TPHCs. VPH analysis of these samples showed that 57D-98-06X contained small concentrations of all carbon fractions; 3.3 μ g/g of C5-C8 aliphatics, 5.6 μ g/g of C9-C12 aliphatics, and 4.3 μ g/g of C9-C10 aromatics. The only other VPH detection occurred in 57D-98-05X which contained 4.2 μ g/g of C9-C12 aliphatics. EPH fractions were detected in only one sample, 57D-98-05X 57D-98-05X contained 630 μ g/g of the C19-C36 aliphatics and 280 μ g/g of the C11-C22 aromatics. The TPHC and EPH detections at 57D-98-05X correspond with the observed distribution of soil contamination at Area 3.

7.2.5 Surface Water

Area 2. During the 1995 RI field phase nine surface water samples, including a duplicate sample, were collected at the eight sediment sample locations (57D-95-03X through 57D-95-10X) in Cold Spring Brook and its associated wetlands in the vicinity of AOC 57 Area 2 (Figure 5-6 and 5-8). Filtered surface water samples were also collected at the toxicity testing locations 57D-95-04X, 57D-95-05X, 57D-95-06X, 57D-95-08X, and 57D-95-10X. Surface water samples were analyzed for select PAL VOCs, SVOCs, inorganics, pesticides, PCBs, TPHC, and water quality parameters. Results of the off-site surface water sample

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analyses are presented in Table 7-19.

Background concentrations for inorganics in surface water have not been established for the Devens area; therefore, inorganic concentrations in the 1995 surface water samples 57D-95-03X through 57D-95-10X were compared against established background concentrations for Devens groundwater. Calcium, iron, manganese, sodium, and zinc were shown to be in excess of background concentrations in the filtered surface water samples. The unfiltered surface water samples also showed exceedances of these compounds as well as aluminum, arsenic, barium, cadmium, chromium, copper, lead, magnesium, mercury, potassium, and vanadium. The bulk of the exceedances occurred in the unfiltered sample from 57D-95-04X. The filtered sample showed exceedances of only calcium and sodium. The large number of background exceedances are attributed to an elevated TSS concentration of 504,000 μ g/g in the unfiltered sample. The greatest number of background exceedances in a filtered sample was observed at 57D-95-05X, located adjacent to Area 2. This sample contained calcium, iron, manganese, sodium and zinc all in excess of background concentrations.

Three additional surface water samples, 57W-98-01X through 57W-98-03X, were collected in 1998 to further characterize the impact of Area 2 on Cold Spring Brook and the associated wetlands. The samples were collected from the same locations as the 1998 sediment samples. The samples were submitted for off-site analysis for PAL VOCs, SVOCs, select inorganics, select dissolved inorganics, pesticides, PCBs, and EPH/VPH. Water quality parameters were also measured at the time of sample collection.

All three of the unfiltered samples contained arsenic, barium, copper, lead, and zinc in excess of background levels. The highest concentrations of all inorganic analytes were observed in 57W-98-02X. None of the filtered samples contained inorganic analytes in excess of background.

In contrast to the sediments, toluene was found in only one of the 1995 Area 2 surface water samples, the upstream sample 57D-95-08X at 0.58 μ g/L. The common laboratory contaminant dichloromethane (methylene chloride) was found in five of the surface water samples. The only other VOCs detections in the 1995 RI surface water samples occurred at 57D-95-05X. This sample was shown to contain 1.8 μ g/L of PCE, 3.5 μ g/L of TCE, and 26 μ g/L of DCE (cis and trans). This sample location is located in the groundwater discharge area southwest of the Area 2 soil removal excavation.

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Similar results were found during the 1998 surface water sampling. 57W-98-01X, collected from a flowing seep on the upstream side of the containment dike, contained 2.6 μ g/L of PCE and 0.6 μ g/L of TCE. This data along with 57D-95-05X indicate that Area 2 is contributing chlorinated organic compounds to surface water. Two VOCs, chloroform at 0.72 μ g/L and carbon disulfide at 1.1 μ g/L were detected in 57W-98-02X. Toluene at 1.1 μ g/L was the only VOC detected in 57W-98-03X.

SVOCs were detected in one of the 1995 RI surface water samples. 57D-95-04X, located upstream of AOC 57 Area 2 contained 0.52 μ g/L of phenanthrene and 24 μ g/L of bis(2ethylhexyl) phthalate. This was also the sample exhibiting the highest TSS.

No SVOCs were detected in the 1998 Area 2 surface water samples.

No pesticides or PCBs were detected in either the 1995 or 1998 surface water samples.

TPHCs were found in two of the 1995 RI surface water samples. 57D-95-04X contained 924 μ g/L and 57D-95-05X contained 247 μ g/L. The detection at 57D-95-04X may be partially attributed to the elevated TSS concentrations observed in the sample.

No VPH carbon fractions were detected in the 1998 Area 2 surface water samples.

The C19 to C36 aliphatic and C11 to C22 aromatic EPH ranges were detected in all of the 1998 surface water samples. The highest concentrations were found in 57W-98-02X which contained 1,700 μ g/L of the C19 to C36 aliphatic range and 1,400 μ g/L of the C11 to C22 aromatic range.

Area 3. Five surface water samples were collected in 1998 from the wetlands immediately south of Area 3. Samples were submitted for off-site analysis for EPH/VPH, PAL VOCs, SVOCs, select inorganics, select dissolved inorganics, pesticides, and PCBs. Surface water sample locations are provided in Figures 5-6 and 5-9. Analytical data are provided in 7-20.

Arsenic, antimony, barium, copper, lead, and zinc were all found in excess of established Devens background groundwater concentrations. 57W-98-05X contained exceedances of all of the above analytes and 57W-98-07X had the fewest exceedances with only barium

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and lead in excess of background. The filtered samples from 57W-98-04X (24 μ g/L), 57W-98-05X (53.4 μ g/L), and 57W-98-08X (12.5 μ g/L) contained arsenic in excess of background levels. These were the only background exceedances in the filtered samples.

Two of the Area 3 surface water samples contained detectable levels of VOCs. 57W-98-05X contained 4.6 μ g/L of chlorobenzene, 0.58 μ g/L of carbon disulfide, and 1.6 μ g/L of toluene. Toluene at 0.59 μ g/L was the only VOC detected in 57W-98-08X.

Benzo[k]flouranthene at 0.94 μ g/L in 57W-98-08X was the only SVOC detected in Area 3 surface water samples.

No pesticides or PCBs were detected in Area 3 surface soil samples.

The C9 to C10 aromatic range was the only VPH fraction detected at Area 3. The surface water sample 57W-98-05X contained 25 μ g/L of the aromatic range.

The EPH C11 to C22 aromatic ranges were detected in every surface water sample. The highest concentration was 650 μ g/L in 57W-98-08X. The 57W-98-08X sample and 57W-98-04X were also found to contain the C19 to C36 aliphatic fraction at 1,100 μ g/L and 1,000 μ g/L, respectively.

7.3 AREA 3 SOIL REMOVAL ACTION

Confirmatory soil samples were collected from the excavation walls and floor following each of the three phases of excavations. The soil samples were submitted for off-site analysis for EPH/VPH, pesticides, and PCBs. The following section summarizes the results of the confirmatory sampling and discusses the residual soil contamination at Area 3. Confirmatory sampling results are provided in Table 7-21 and sampling locations are shown in Figure 5-9.

VPH carbon ranges were detected along the eastern and western walls of the southern tongue of the excavation. The highest concentrations were detected along the western wall approximately 40 feet north of the southern terminus of the excavation where EX57W16X at 2 feet bgs was shown to contain 890 μ g/g of C9 to C12 aliphatics and 600 μ g/g of C9 to C10 aromatics. Elevated VPH levels were also found in EX57W14X

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which contained 52 μ g/g of the C9 to C12 aliphatics and 55 μ g/g of the C9 to C10 aromatics.

Elevated levels of EPH were found at 1 to 2 feet bgs along the southern extent of the excavation. The highest concentrations were found in EX57W14X which contained 920 μ g/g of C9 to C18 aliphatics, 20,000 μ g/g of C19 to C36 aliphatics, and 3,100 μ g/g of C11 to C22 aromatics. EX57W15X and EX57W16X also contained high levels of EPH aliphatic and aromatic ranges.

The pesticides dieldrin, endrin, and 4,4'-DDD were found coincident with the EPH detections in the southern portion of the excavation. Dieldrin was found at 2 feet bgs in EX57W14X and EX57W16X at 0.14 μ g/g and 0.086 μ g/g, respectively. EX57W16X was the only sample to contain endrin 0.07 μ g/g. Low levels of 4,4'-DDD, 0.24 to 0.29 μ g/g, were detected at 1 to 2 feet bgs in EX57W15X, EX57W16X, and EX57F01X.

Residual PCB contamination was detected at 2 feet bgs in EX57W14X at 4.3 μ g/g. PCBs were also detected in the floor sample EX57F01X at 2.6 μ g/g. PCB detections consisted of the congener Aroclor 1260.

Residual contamination is located at 1 to 2 feet bgs in the southern portion of the excavation in the vicinity of EX57W14X, EX57W15X, and EX57W16X. The Removal Action showed that the soil contamination was primarily confined to a subsurface zone of eluviated organic silty sand varying in thickness from 2-inches to 1-foot. This layer varied in depth from three to five feet in the northern source area to 1-foot in the southern extent of the excavation.

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8.0 CONTAMINANT FATE AND TRANSPORT

This subsection discusses the migration potential and probable environmental fate of general contaminant groups identified at AOC 57 Areas 2 and 3. Compounds and analytes detected include VOCs, SVOCs, inorganics, and TPHC. The observed distribution of these contaminants in different environmental media (soil, groundwater, sediment, and surface water) is the result both of the release pattern and of their physical and chemical properties. For organic chemicals, these properties include specific gravity, solubility, volatility, and organic carbon partition coefficient (K_{oc}). For inorganic constituents, the physical and chemical and chemical properties include oxidation state of the analyte, pH, and specific solute species. Site-specific conditions governing fate and transport (e.g., persistence and migration) of analytes include contaminant concentration, topography, meteorological conditions, and in the case of groundwater, hydrogeology.

8.1 COMPOUND PROPERTIES AND TRANSPORT PROCESSES

The primary contaminants detected in soil at AOC 57 are fuel, waste oil, and solvent-related VOCs, SVOCs, TPHC and PCBs. In addition, some VOCs and SVOCs may have been introduced in samples as laboratory contamination.

The persistence of compounds in soil is determined by chemical properties, source configurations and releases, geochemical and biochemical reactions, and soil and meteorological conditions. Factors and processes that control the persistence of chemicals in water-bearing units, in addition to the aforementioned factors, are water-bearing unit characteristics, advection, and hydrodynamic dispersion. Compounds may exist in the surface and subsurface in gaseous, aqueous, or solid phases. The fate of these compounds is controlled by a combination of all of these factors.

The following subsections discuss general physical and chemical properties, and how these properties affect transport and general attenuation processes.

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8.1.1 Physical and Chemical Properties Significant to Fate and Transport

This subsection discusses the physical and chemical properties that affect the fate and transport of contaminants in the environment. Physical and chemical properties of organic contaminants of concern detected at AOC 57 are presented in Table 8-1. Table 8-2 summarizes the relative mobilities of selected inorganic elements in different chemical environments.

Most physical and chemical properties of Target Compound List (TCL) analytes, including specific gravities, K_{oc} , relative solubility, and relative volatility, are described in "Basics of Pump-and-Treat Groundwater Remediation Technology" (USEPA, 1990b). This reference document does not include inorganics, because analyses conducted measure the total amount of a particular constituent in the sample rather than the actual chemical form or metal oxidation state. The distribution of specific solute species, pH, and oxidation are important factors in establishing the total solubility or mobility of a given inorganic element.

Specific gravity is the ratio of the mass of a given volume of a liquid substance to the mass of an equal volume of water. Liquids with specific gravities greater than 1 are termed "heavier" than water.

Solubility measures the partitioning between the aqueous phase and solid form of a chemical, and the tendency of a material to dissolve in water. Substances with lower solubilities are more likely to remain in a separate phase when in contact with water; substances with higher solubilities will dissolve into, and move with, water.

Volatility measures the tendency of a chemical to partition into the gaseous phase. Volatility can be predicted by an analyte's vapor pressure and Henry's Law Constant value (H). Volatility of a compound increases with increasing vapor pressure. Compounds with H values less than 1.0×10^{-5} (e.g., dimethyl phthalate pyrene) have a low degree of volatility, and those with H values below 3.0×10^{-7} are considered non-volatile (PCBs). H values between 1.0×10^{-5} and 1.0×10^{-3} (e.g., naphthalene and phenanthrene) are moderately volatile, while those with values exceeding 1.0×10^{-3} (e.g., VOCs) are considered highly volatile.

 K_{oc} measures the extent that an organic chemical partitions between a solid phase and a liquid phase, and is used to predict to what extent a chemical could be adsorbed to soil

organic carbon. Chemicals with a K_{oc} greater than 10,000 will adsorb strongly to soil organic carbon (e.g., fluoranthene, phenanthrene, and pyrene) Chemicals with a K_{oc} ranging from 1,000 to 10,000 will moderately adsorb, and move slowly in the soil profile (e.g., naphthalene). Chemicals with a K_{oc} of less than 1,000 weakly adsorb to soil organic carbon and tend to be more mobile. Examples of weakly adsorbed compounds include many VOCs such as benzene and xylene.

8.1.2 General Transport and Attenuation Processes

Migration and persistence are controlled by various transport and attenuation processes. Processes that tend to disperse contaminants include surface water and groundwater movement (which includes the movement of dissolved and suspended contaminants), facilitated transport, leaching by dissolution or desorption, and surface erosion.

The solubility of a compound in water is considered to be the most important transport factor, because it determines the maximum concentration dissolved in water. Knowledge of the solubility of a chemical provides considerable insight into the fate and transport of that chemical. In general, highly soluble compounds are less likely to partition into soil or sediment, or to volatilize from water, and are more likely to biodegrade (Montgomery, 1991).

Dissolved phase transport can occur via two processes: advection or dispersion. Advection involves transport with flowing groundwater and migrating with the mean velocity of the solvent (groundwater plus dissolved compounds). When compounds move through the ground by advection, they are subject to spreading within the ground, which allows compounds with little or no affinity for soils to migrate faster than the mean groundwater velocity. This spreading is the result of a process known as dispersion. Hydrodynamic dispersion has two components: molecular diffusion and mechanical dispersion (USEPA, 1989a). Diffusion is the process by which ionic or molecular constituents move under the influence of concentration gradients. Mechanical dispersion occurs as the groundwater flows through the media, and compounds spread out through the tortuous pathways of the soil matrix, and mix with clean water. The result is a dilution of the compound by a process known as dispersion (Fetter, 1988). At very low groundwater velocities, diffusion is the dominant process; at higher velocities, mechanical dispersion is the dominant process. Dispersivity is dependent on vertical and horizontal permeability variations, increasing with the degree of heterogeneity and anisotropy, and is dependent on whether flow is principally

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through porous media or nonporous media (e.g., fractured bedrock) (Walton, 1988).

The rate a compound migrates can be influenced by facilitated transport, which is the combined effects of physical, chemical, and/or biological phenomena that act to increase mobility. Examples of facilitated transport include particle transport, cosolvation, and phase shifting (Keely, 1989).

Particle transport involves the movement of small, solid-phase particles (such as inorganic and organic colloids), macromolecules, or emulsions to which compounds have adhered by sorption, ion exchange, or other means. High molecular weight organic compounds such as polynuclear aromatic hydrocarbons (PAHs), pesticides, PCBs, and heavy metals, have a high affinity for mobile subsurface particles, and this affinity increases their mobility (Huling, 1989). Small particles, especially mobile organic carbon phase particles such as biocolloids and macromolecules (e.g., humic substances) are transported in the aqueous phase and may act as mobile sorbents.

Cosolvation is the process by which the solubility and mobility of one compound is increased by the presence of another (Keely, 1989). Naturally occurring organic compounds (e.g., humic acids) can undergo complexation reactions with metals and pesticides. Complexation reactions can increase the solubility of metals (including iron, aluminum, copper, nickel, and lead) and pesticides (e.g., dichlorodiphenyl trichloroethane [DDT]). In a cosolvent system, as the fraction of a water-miscible cosolvent increases, the solubilities of the metals or pesticides increase. However, the cosolvent concentration normally needs to be high to ensure a substantial increase in solute velocity. Therefore, cosolvation is important primarily near sources of groundwater impact (USEPA, 1989a). High concentrations of water-miscible phases (e.g., ketones) were not detected at AOC 57.

Chemical phase shifts involve changes in pH and/or the redox potential of the groundwater. These shifts can increase solubilities and mobilities by ionizing neutral organics, solubilizing precipitated metals, forming complexes, or limiting biological activity (Keely, 1989). These processes are particularly important in determining the mobility of heavy metals. Inorganics and heavy metals may be related to historic disposal practices at AOC 57.

Processes that tend to attenuate migration of impacted groundwater include retardation resulting from sorption, volatilization, degradation, and precipitation. The sorption properties of individual solutes are dependent on soil and groundwater characteristics. In general, the relative amount of sorption by soil or sediment materials that do not contain organic matter is as follows: clay > silt > sand > gravel (Walton, 1988). The soil beneath AOC 57 is a silty sand to sand. Sorption would be expected to exert a moderate to minimal influence in retarding the migration of fuel-related VOCs and SVOCs in the soil and a strong influence on retarding PCB migration in soil.

The tendency of organic chemicals to be sorbed is also dependent on the organic content of the soil and the degree of hydrophobicity (lack of affinity for water) of the solute (contaminant). The rate of travel for each chemical depends on the groundwater seepage velocity and the degree of sorption. If an organic chemical is extensively adsorbed by particles, it will be rendered relatively immobile. The rates and degree of volatilization, photolysis, hydrolysis, and biodegradation are directly dependent on the extent of adsorption (Montgomery, 1991). The vadose zone typically contains greater amounts of organic material and metal oxides (which may also act as sorbents) than the saturated zone, which may make the rate of movement in the vadose zone substantially less than that in the saturated zone (USEPA, 1989a).

The soil partition or sorption coefficient (K_{oc}) is defined as the ratio of adsorbed chemical per unit weight of organic carbon to the aqueous solute concentration. The coefficient indicates the tendency of a compound to adsorb to organic carbon (degree of retardation) and, therefore, provides a means for estimation of the relative mobility of solutes (Montgomery, 1991). Mobility is a function of the relative rate of transport of a chemical versus the rate of groundwater flow. Chemicals that have relatively low mobilities (i.e., high retardation or sorption) move slowly compared to the velocity of the groundwater. Chemicals that have relatively high mobilities (i.e., low retardation or sorption) move at a rate closer to groundwater velocity. VOCs detected at AOC 57 have relatively high mobility potential, while SVOCs have moderate to high mobility potential (Table 8-1).

Volatilization is the transport of a compound from the liquid to the vapor phase and, ultimately, into the atmosphere. Volatilization rates are affected by soil properties, vapor pressure, temperature, and sorption. VOCs partition between the aqueous and gaseous phase in unsaturated soils. This process will occur most readily for compounds with a high vapor pressure and a high H. These compounds tend to partition off into the gas phase and

occupy the available soil pore space. In addition, VOCs in the saturated zone or in surface water will partition to the gaseous phase, particularly those with lower solubility (e.g., xylenes). VOCs with greater aqueous solubility (e.g., benzene) tend to remain in solution.

Volatilization is an important process in shallow soils and surface water. In recharge areas composed of sandy or gravelly soil, volatilization may be an important process, especially for compounds with moderate to high volatility (Montgomery, 1991). The effectiveness of volatilization normally decreases with depth in the soil column.

Chemicals released to the environment are susceptible to several degradation pathways, including chemical degradation (e.g., oxidation and reduction); photolysis or photochemical degradation; and biodegradation. Compounds formed by these processes may be more or less toxic and/or more or less mobile than the parent compound.

Oxidation typically involves the loss of electrons during a chemical reaction. In general, substituted aromatic compounds such as ethylbenzene and naphthalene can be oxidized. Oxidation rates for aromatic compounds are typically an order of magnitude faster than for chlorinated aliphatic compounds (e.g., 1,2-dichloroethane [1,2-DCA]). Overall, abiotic (without biological life) oxidation of organic compounds in groundwater systems is limited.

Photochemical breakdown processes involve structural changes in a molecule induced by radiation in the ultraviolet-visible light range. This process may occur in surficial soils at AOC 57 but would not affect contamination in the subsurface soils.

Biodegradation may be defined as the breakdown of organic compounds by microorganisms through metabolic processes. Variables affecting the rate of biodegradation include:

- number of microorganisms
- chemical properties, concentrations, and distribution
- presence of food and nutrients
- temperature
 - pH

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• moisture and oxygen content

The rate of biodegradation tends to be higher for low molecular weight compounds. Naturally occurring soil and aquatic microorganisms capable of degrading aromatic hydrocarbons (e.g., BTEX) have been studied, and a relationship between dissolved oxygen and biodegradation has been documented (Jamison, et al., 1975; and Bailey, et al., 1973). As the aromatic hydrocarbons are mobilized by dissolution from soil or sediment, they are likely to be rapidly degraded as long as microorganisms and dissolved oxygen are available. Degradation rates for aromatic hydrocarbons are much slower under anaerobic conditions.

8.2 FATE AND TRANSPORT OF CONTAMINANTS DETECTED AT AOC 57

This subsection discusses the potential fate and transport of contaminants, by chemical class, detected at AOC 57.

VOCs. Soil samples collected at or below the water table at AOC 57 contained the fuelrelated VOCs TEX as well as the chlorinated aliphatics PCE, TCE, 1,1,1-TCA, 1,2-DCE (cis and trans), chloroform, and carbon tetrachloride (see Tables 7-12 and 7-13). Fuelrelated VOC TICs such as 1-ethyl-2-methylbenzene, 4-(1-methylethyl) toluene, 1,2,4trimethylbenzene, and octane were also present in the soil samples (see Table 7-1). TEX and chlorinated aliphatics are the primary VOCs detected in groundwater samples from AOC 57 (see Table 7-12 and 7-13). Chloroform and dichloromethane were also detected in downgradient monitoring wells. No fuel related TICs were identified in groundwater.

VOCs detected at AOC 57 can be classified as aromatic hydrocarbons (e.g., BTEX) and chlorinated aliphatics (e.g., PCE). Processes and forces that will control the fate of these VOCs include volatilization, advection/dispersion, and biodegradation.

Factors affecting VOC percolation to groundwater are density and volatility. Compounds with higher density and low volatility are most likely to be transported to groundwater.

Dissolution of VOCs from unsaturated zone soil via infiltrating precipitation may be a transport mechanism at AOC 57 due to the sandy nature of the soils and the relatively shallow water table.

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Volatilization is believed to be the most significant transport mechanism for VOCs in the unsaturated soils at AOC 57. The fuel-related VOCs at AOC 57 are likely partitioning between the aqueous and gaseous phases in the source area unsaturated soils. This process occurs most readily for compounds with a high vapor pressure and a high H (e.g., benzene and toluene). In addition, VOCs in the saturated zone will partition to the gaseous phase, particularly those with lower solubility (e.g., TEX). As groundwater transports the fuel-related VOCs away from the source areas, the VOCs with lower solubility will partition to some extent into the gas phase and occupy the available soil pore space above the water table in the unsaturated zone. VOCs with greater aqueous solubility (e.g., benzene) tend to partition more strongly to the aqueous phase.

Dissolved phase transport of VOCs in groundwater is a significant transport mechanism at AOC 57. Factors affecting partitioning of VOCs from soil to groundwater include solubility and K_{oc} . VOCs with high solubilities and low K_{oc} s, such as benzene, will partition to groundwater from the saturated zone soils. Toluene, ethylbenzene, and xylene were detected in saturated zone soils and groundwater, which is probably a result of the moderate K_{oc} s and solubilities (see Table 8-1). Processes that tend to attenuate migration of impacted groundwater at AOC 57 include retardation resulting from sorption, volatilization, and degradation.

Biodegradation reactions act to reduce the total mass of VOCs. Naturally occurring soil microorganisms capable of degrading aromatic hydrocarbons have been studied, and a relationship between dissolved oxygen and biodegradation has been documented (Jamison, et al., 1975; and Bailey, et al., 1973). As the aromatic hydrocarbons are mobilized by dissolution from the soil or sediment, they are likely to be rapidly degraded as long as dissolved oxygen and sufficient microorganisms are available.

Fuel-related VOC contaminants at AOC 57 are expected to be reduced through volatilization, biodegradation, and/or dilution and dispersion.

SVOCs. Soil samples collected at or below the water table at AOC 57 contained fuelrelated SVOCs (see Tables 7-12 and 7-13). Fuel-related SVOC TICs such as trimethylbenzene, 1,1,2,2-tetrachloroethane, 1-ethyl-2-methylbenzene, and nonacosane were also present in the soil samples (see Table 7-1). 1,2-DCB, 1,4-DCB, naphthalene, 2methylnaphthalene and phthalates are the primary SVOCs detected in groundwater samples

from AOC 57. Fuel-related SVOC TICs in groundwater include indan and hexadecanoic acid (see Table 7-1).

Dissolution of SVOCs from unsaturated zone soil via infiltrating precipitation may be a probable transport mechanism at AOC 57 due to the sandy nature of the overburden soils.

Volatilization is a minor transport mechanism for SVOCs in the soils and groundwater at AOC 57. The fuel-related SVOCs at AOC 57, such as naphthalene and phenanthrene, are considered moderately volatile, and therefore volatilization is not as significant a transport mechanism as it is for VOCs.

Dissolved phase transport of SVOCs in groundwater is a significant transport mechanism at AOC 57. Factors affecting partitioning of SVOCs from soil to groundwater include solubility and K_{oc} . SVOCs are generally regarded as immobile because of strong adsorption to the organic carbon fraction of soil predicted through higher K_{oc} s and low solubilities (Tinsley, 1979; Kenaga and Goring, 1978). SVOCs with moderate solubilities and moderate to high K_{oc} s, such as pyrene and phenanthrene, will partition slightly to groundwater from the saturated zone soils (see Table 8-1). Results of saturated zone soil samples and groundwater. Processes that tend to attenuate migration of impacted groundwater at AOC 57 include retardation resulting from sorption, volatilization, and degradation.

Biodegradation reactions act to reduce the total mass of lower molecular weight PAHs (e.g., naphthalene). Naturally occurring soil microorganisms capable of degrading aromatic hydrocarbons have been studied, and a relationship between dissolved oxygen and biodegradation has been documented (Jamison, et al., 1975; and Bailey, et al., 1973). As the aromatic hydrocarbons are mobilized from the soil by groundwater movement, they are likely to be degraded as long as dissolved oxygen and sufficient microorganisms are available.

The fate of fuel-related SVOC contaminants at AOC 57 is expected to be reduction through volatilization, biodegradation, and/or dilution and dispersion. The slow rate of migration (due to partitioning to soil) for the PAHs allows for significant degradation, even if degradation rates are small, before they can travel significant distances. The fuel-related PAHs also tend to be more persistent with increasing molecular weight.

PCBs. Soil samples collected at AOC 57 during the RI contained the individual PCB compounds (congeners) Aroclor 1242, Aroclor 1248, and Aroclor 1260. The different congeners are described by the percent of chlorine; for example Aroclor 1260 contains 60% chlorine by weight.

PCBs are characterized as being relatively insoluble and having low volatility and tend to sorb strongly to soils. Solubility and volatility have in inverse relationship to the degree of chlorination of the individual congeners. Dissolution and volatilization are not significant transport mechanisms for PCBs at AOC 57.

PCBs are also persistent in the environment as a result of their general resistance to degradation.

Inorganics. Inorganics detected at AOC 57 include metals (aluminum and lead), transition metals (iron, manganese, vanadium, chromium, cobalt, nickel, zinc, and copper), alkaline earth metals (calcium, magnesium, and barium), alkali metals (sodium and potassium), and nonmetallic elements (arsenic). The detection of these inorganics, it should be noted, could not be correlated with the presence of fuel-related organic compounds (see Section 7.0 of this report). Discussion of the fate and transport of inorganics, presented below, is therefore limited.

The mobility of inorganics in soil-water systems is strongly affected by compound solubility, pH, soil cation exchange capacity, soil type, oxidation-reduction potential, adsorption processes, major ion concentrations, and salinity. The distribution of inorganics would most likely be controlled by adsorption processes. Once adsorbed to soil, the inorganics may migrate with the soil by mechanical transport of particles. The migration of dissolved inorganics is dependent upon their individual adsorption characteristics (Oak Ridge National Laboratories, 1989). Mobilities of inorganic elements relative to the redox state of the environment are presented in Table 8-2.

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8.3 SITE CONCEPTUAL MODEL

Figure 8-1 presents a simplified site conceptual model flow chart encompassing the essential features of AOC 57 Areas 2 and 3 and showing the potential source and transport mechanisms for the contaminants detected at AOC 57. The model reflects the current understanding of the site with respect to sources of contamination, the distribution of contamination, and the potential migration pathways.

Based on the results of the RI, the primary site-related contaminants at AOC 57 are solvent and fuel-related contaminants in soil and groundwater. VOCs, SVOCs, pesticides, PCBs, and TPHC were detected during the investigation.

Based on the results of the field investigation, it appears that the Area 2 contaminant source was contaminated surface and near surface soils located in the vicinity of the soil removal excavation. The soil contamination is believed to be due to disposal of vehicle maintenance wastes. The Area 3 contaminant source is the historic disposal site identified by test pitting at 57E-95-24X.

The primary release mechanism at both areas appears to infiltration into groundwater from source area contaminants above the water table. Potential secondary release mechanism is the contaminated soil downgradient of the source areas. The contaminated soil downgradient of the source areas is believed to be due to sorption of dissolved phase contaminants.

The migration pathways/transport mechanisms appear to be groundwater flow of dissolved contaminants.

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9.0 RISK ASSESSMENT

9.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

Overview

A human health risk assessment has been conducted to evaluate potential health risks to individuals under current and foreseeable future site conditions at AOC 57. The methods used to perform the risk assessment are consistent with relevant national and regional USEPA risk assessment guidance (e.g., Risk Assessment Guidance for Superfund (USEPA, 1989a); USEPA New England Risk Updates (USEPA, 1992a; 1994a; 1995; 1996) and incorporate data from the various remedial investigation and removal action sampling activities at AOC 57.

The assessment for AOC 57 consists of the following components:

- Selection of Chemicals of Potential Concern (CPCs)
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Evaluation
- Summary and Conclusions

Summary of Site History

AOC 57 is located approximately 3,800 feet southwest of the Barnum Road Gate, between Barnum Road and Cold Spring Brook (Figure 9-1). AOC 57 is in an area of Devens that has been used primarily for the storage and maintenance of military vehicles. AOC 57 consists of three subsites (Area 1, Area 2, and Area 3) which received storm water runoff and wastes from vehicle repair at the adjacent former vehicle storage yard associated with Buildings 3757 and 3758. The vehicle storage yard was abandoned in 1998, and the pavement and fencing were removed. The former storage yard is now a soil and grass-covered area.

Areas 1, 2, and 3 are located between Barnum Road and Cold Spring Brook (Figure 5-2). This area includes an upland area (elevations between 228 and 240 ft mean sea level

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[msl]) that slopes downward to a delineated wetland area (elevations lower than 228 ft msl). At Area 2 the wetland boundary is located approximately 250 feet from Cold Spring Brook, and at Area 3 the wetland boundary is located approximately 500 feet from Cold Spring Brook. The upland area is forested with trees and scrub brush. The wetland area is densely vegetated with brush and contains small areas of standing water.

Area 1 was investigated and addressed as part of the AREE 70 investigation (ADL, 1995). This area underwent a soil removal action to address TPHC and PAH contamination from parking lot runoff. Although some residual TPHC and PAH concentrations remained in Area 1 soils after the removal action, the contamination was determined to be consistent with soil and sediment at stormwater outfalls throughout Devens. Therefore, Area 1 was recommended for no further action (Weston, 1998); the decision is to be formalized in the AOC 57 ROD. However, in accordance with recent USEPA requirements for site closure, a no further action decision must be supported by the demonstration that a site does not pose an unacceptable risk for future unrestricted land use. Area 1 was not investigated as part of this RI, but is included here for completeness. An assessment of risks associated with unrestricted future land use at Area 1 indicates that residual contamination at Area 1 does not pose an unacceptable risk for future land use at Area 1 indicates that residual contamination at Area 1 does not pose an unacceptable risk for future land use the area 1 indicates that residual contamination at Area 1 does not pose an unacceptable risk for future land use at Area 1 indicates that residual contamination at Area 1 does not pose an unacceptable risk for future land use (Appendix N-1).

Area 2, formerly an eroded drainage ditch created by periodic rain runoff, was investigated following detection of naphthalene and TPHC in surface soils during a 1993 site investigation. Subsequent sampling confirmed the presence of TPHC and PAHs in surface soil. In addition, these classes of compounds were also detected in sediment samples from Cold Spring Brook, although the distribution of these contaminants did not indicate that AOC 57 was the source. Based on the results of these investigations, the Army performed a soil removal action at Area 2 in 1994. Approximately 1,300 cubic yards of soil were excavated during the removal action. At the completion of the removal action, the area was regraded and a permanent drainage swale was installed. Results of sampling conducted during and at the completion of the removal action in 1994 indicated the presence of TPHC, PCBs, lead, and VOCs in soil and/or groundwater at the site. Additional sampling conducted in 1998 focussed on delineating the extent of contamination in soil and groundwater at Area 2, and surface water and sediment in the floodplain between Area 2 and Cold Spring Brook. These data indicate that contamination associated with Area 2 is located primarily near the southern portion of the removal action excavation.

Area 3 is located approximately 600 feet northeast of Area 2. This area was investigated in 1995 and 1996 to address soil staining observed in historical photos. Results of the soil and groundwater sampling indicated elevated concentrations of TPHC, as well as PCBs and PAHs in soils. Additional sampling conducted in 1998 focussed on delineating the extent of contamination in soil and groundwater at Area 3, and surface water and sediment in the floodplain area between Area 3 and Cold Spring Brook. These data indicate that contamination associated with Area 3 extends from the upland area at the top of the slope adjacent to the former motor pool area, approximately 70 feet into the delineated wetland (Figure 9-1). Based on the findings from these field investigations, the Army performed a soil removal action in 1999. Approximately 1,860 cubic yards of soil were removed from Area 3. Confirmatory soil sampling indicated that the majority of the PCB and TPHC contaminated soil were removed from Area 3.

Site Conceptual Model

The RI identified soils contaminated with petroleum in two areas adjacent to the former motor pool yard (Area 2 and Area 3). Figure 9-2 graphically presents the site conceptual model, which relates sources of petroleum-related contamination to migration pathways and the environmental media which human and ecological receptors may potentially be exposed to. The conceptual model applies to Area 2 and Area 3, and is based on the findings of the RI and supplemental sampling.

As indicated in Figure 9-2, petroleum was released to the surface and subsurface soils (as motor oil, hydraulic fluid, and other heavy oils; no fuel oil is believed to have been released to the soils). The petroleum contamination, which was quantified in this RI by measuring TPHC, EPH and VPH fractions along with their associated target analytes (i.e., BTEX and PAHs), primarily contained EPH; VPH, VOCs, and PAHs were detected sporadically and at low concentrations. Petroleum contamination in the source area (on the upland slope and wetland area nearest to the slope) extended from the surface to approximately 10 feet bgs, whereas contamination was limited to the top two to three feet of soil in the more distant wetland areas. PCBs, principally comprised of Aroclor-1260, were also detected in petroleum-contaminated soils. Inorganic analytes, particularly arsenic, iron, and manganese, were detected in site soil and groundwater, as well as surface water and sediment in the wetland area.

EPH and PCBs tend to adsorb to soils and do not readily leach to groundwater or migrate in groundwater. The RI did not identify substantial petroleum-related contamination in

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groundwater at AOC 57. EPH was detected at a low frequency and concentration. This indicates that petroleum contamination has not leached from soils to groundwater. Groundwater at AOC 57 is approximately 10 feet bgs at the top of the slope near the former motor pool lot, and approximately 1 to 2 feet bgs in the wetland area. Groundwater flows toward Cold Spring Brook, and discharges to the wetland soils as seeps and small ponded areas when the groundwater level is high. Since petroleumrelated compounds were not detected in Area 2 and Area 3 groundwater, it appears that these constituents have not migrated to wetland soils or Cold Spring Brook via groundwater discharge. Similarly, petroleum-contaminated soils do not appear to have migrated to Cold Spring Brook via overland flow and erosion. Based on this information, the principal exposure pathways to site-related petroleum contamination include ingestion and dermal contact with surface soil and subsurface soil in the upland and wetland areas, as well as inhalation of soil-derived particulates. Vapor migration to ambient air or to air within buildings that could be constructed at the site does not appear to be a substantial exposure pathway because EPH, PCBs, and inorganics are not volatile, and VPH and VOCs were detected at relatively low concentrations in soil and groundwater.

VPH chains, as well as VOCs and soluble inorganics, can leach from the soil and migrate in groundwater. Although VPH and VOCs were detected only at low concentrations in groundwater, arsenic, iron and manganese were detected in groundwater at concentrations above Devens background. These constituents are mobile in groundwater, and could potentially discharge to wetland soils in groundwater seeps, or to surface water. Once in surface water the inorganics may adsorb to sediment. Arsenic, iron, and manganese, as wells as additional inorganics, were detected in wetland soils, sediments, and surface water.

There has been no documented disposal of inorganic constituents at AOC 57, and no apparent disposal areas or source areas of inorganic contamination were identified during the RI. The detection of inorganic constituents in groundwater and wetland soils is more likely caused by leaching of naturally-occurring inorganics from the petroleum-contaminated soils. Reducing conditions, created by the biodegradation of petroleum compounds in soils, would enhance leaching of inorganic constituents from soil to groundwater. In the reduced state, the inorganic constituents would more easily migrate in groundwater. However, upon discharge to surface water, these inorganics would tend to oxidize and then adsorb to soil or sediment and become less mobile. This cycle of reduction/migration/discharge/oxidation could account for the detections of inorganic constituents in groundwater and wetland soils. As discussed in Section 8.0, inorganics

that are interpreted to be related to AOC 57 are located in groundwater and wetland soils at Areas 2 and 3. Inorganics detected in Cold Spring Brook are not interpreted to be related to AOC 57 based on two primary lines of evidence: 1) arsenic concentrations in wetland sediments decrease with distance from AOC 57; 2) arsenic concentrations in the reach of Cold Spring Brook adjacent to AOC 57 are consistent with or lower than arsenic concentrations detected upstream of AOC 57. Therefore, contamination associated with AOC 57 has not migrated to the Cold Spring Brook stream channel. Nonetheless, to reduce petroleum contamination in soils and to mitigate possible continued leaching of naturally-occurring inorganics, the Army conducted soil removal actions at Area 2 (1994) and Area 3 (1999).

Based on this information, the principal exposure pathways to inorganic constituents are associated with incidental ingestion and dermal contact with surface soil and subsurface soil, as well as ingestion and dermal contact with surface water and sediment in the wetland. Potable use of groundwater could also provide an exposure pathway to inorganic constituents, although groundwater at AOC 57 is not within a potentially productive aquifer and is therefore not considered a drinking water resource by the State of Massachusetts.

According to the Devens Reuse Plan (Vanasse Hangen Brustlin, Inc., 1994), the land in the vicinity of AOC 57 is designated for reuse as "Rail, Industrial, Trade-Related" in the upland area, and as "Open Space" in the delineated wetlands. Under the present and anticipated future land use conditions, people who may occupy the site include trespassers, recreational visitors, maintenance workers, commercial workers, and excavation workers.

9.1.1 Selection of Chemicals of Potential Concern

The first step in the risk assessment involves compiling and evaluating the analytical site data to identify those chemicals present in environmental media as a result of potential sources at AOC 57. Site-related chemicals that were selected for risk evaluation are referred to as CPCs.

9.1.1.1 Identification and Selection of Analytical Data. Samples were collected at AOC 57 from surface and subsurface soil, sediment, surface water, and groundwater. The sampling and analytical programs are discussed in Section 5.0.

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<u>Soil</u>

Surface and subsurface soil samples were collected throughout the source areas during the RI (Figure 9-1). For the human health risk assessment, surface soil was defined as extending from 0-2 feet bgs, and subsurface soil was defined as extending from 2 to 10 feet bgs (there were no samples collected from depths greater than 10 feet bgs). Although USEPA Region I defines surface soil as 0-1 foot bgs (USEPA, 1995), "surface soil" samples collected in 1995/1996 represented soil 0-2 ft bgs. To ensure data comparability, samples collected 0-1 foot bgs and 1-2 foot bgs in the 1998 field program and 1999 removal action at Area 3 were considered surface soils in the risk assessment.

Soil data used in the risk assessment are from field programs performed in 1995/1996 and 1998, and the Area 3 soil removal action performed in 1999. Due to the differences in proposed future land uses between the wetland and upland areas of the site, soil data for each subsite were segregated by upland and wetland areas, based on the sample locations relative to the wetland boundary. In the human health risk assessment, upland areas are referred to as industrial use areas, and wetland areas are referred to as recreational use areas. Table 9-1 presents a summary of the sample locations and analytical parameters associated with each data set evaluated in the risk assessment.

As shown in Table 9-1, samples collected in the 1995/1996 field programs were analyzed for inorganics, pesticides/PCBs, SVOCs, VOCs, and TPHC. Samples collected in the 1998 field program were analyzed for the same parameters, as well as EPH and VPH and associated target analytes. Confirmatory soil samples collected during the Area 3 soil removal were analyzed for EPH, VPH, and pesticides/PCBs, since the removal actions were performed to address petroleum and PCB contamination. All data used in the risk assessment are from off-site laboratory analyses. Although field screening analyses for TPHC and VOCs were performed during the 1995/1996 field programs, the data generated by those analyses is considered unsuitable for use in risk assessment. A review of the off-site laboratory data and field screening data indicate that samples which only received field screening analyses had low or non-detectable petroleum (i.e., TPHC) concentrations; samples which had elevated petroleum concentrations were submitted for off-site laboratory analyses. Therefore, excluding the field screening data from the risk assessment does not lend to underestimation of risk.

Samples collected during the 1995/1996 and 1998 field programs that were associated with soil that was removed during the Area 3 soil removal action were not included in the

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risk assessment (Table 9-2).

As explained in Subsection 9.1.3, the risk assessment evaluates possible exposures to petroleum using EPH and VPH data. This is a preferable approach because it allows for a site-specific assessment of the petroleum-related constituents, and is consistent with the MADEP petroleum policy (MADEP, 1997). TPHC data for samples collected during the 1995/1996 field programs (for which EPH/VPH analyses were not performed) was converted to EPH and VPH equivalent fractions for use in the risk assessment. This procedure is documented in Appendix N-2.

Groundwater

Groundwater data were collected from monitoring wells at AOC 57 during the 1995/1996 and 1998 field programs (Figure 9-1). Due to the differences in proposed future land uses between the wetland and upland areas of the site, groundwater data for each subsite were segregated by upland and wetland areas. In addition, groundwater data from wells located upgradient of Area 2 were grouped separately. Table 9-3 presents a summary of the sample locations and analytical parameters associated with each data set evaluated in the risk assessment.

As shown in Table 9-3, samples collected in the 1995/1996 field programs were analyzed for inorganics, pesticides/PCBs, SVOCs, VOCs, and TPHC. Samples collected in the 1998 field program were analyzed for the same parameters, as wells as EPH and VPH and associated target analytes. Inorganics were analyzed in both unfiltered and filtered samples. All data used in the risk assessment are from off-site laboratory analyses.

The most recent groundwater data from each monitoring well was evaluated in the risk assessment so that risks reflect the most current groundwater conditions (e.g., post-soil removal action). For most wells, the data collected in the 1995/1996 field programs represent the most recent data. The majority of 1998 groundwater data represent samples collected from piezometers or monitoring wells that were installed during the 1998 field program. The remainder of the 1998 data is for EPH/VPH analyses from re-sampling some previously existing monitoring wells.

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Surface Water and Sediment

Surface water and sediment samples were collected from small ponded areas of standing water in the wetland (Figure 9-1). The sediment and surface water sampling and associated data are described in detail in Sections 5.0 and 7.0. In summary, surface water and sediment samples collected during the 1995/1996 RI were analyzed for VOCs, SVOCs, pesticides/PCBs, inorganics, and TPH. Surface water and sediment samples collected in 1998 were analyzed for EPH/VPH and inorganics to better define the nature and extent of these analytes.

The procedures used to evaluate and summarize data and to screen data for the selection of CPCs are discussed below.

9.1.1.2 Data Summary Procedures. Prior to selecting CPCs, the analytical data were grouped into data sets for each area and medium. The following steps, which are in accordance with USEPA (1989a; 1992c) guidance, were used to summarize the analytical data for this risk assessment:

Data quality was evaluated by validating the data in accordance with USEPA data quality assessment procedures (USEPA, 1989c). Data suitable for use in risk assessment (i.e., those not rejected) were used in the risk assessment. Data qualified as estimated and blank-contaminated were used in the risk assessment; uncertainties that may affect the risk assessment results are discussed in Subsection 9.1.5. Several TICs were detected in surface and subsurface soil, groundwater, and sediment, but they are not included in this evaluation because they were few in number and low in concentration compared to identified analytes. A summary of TICs is provided in Table 7-1. The data quality assessment is provided in Appendix D.

Data were summarized by environmental medium (for example, surface soil, groundwater). All chemicals detected in at least one sample in each data set were identified.

The arithmetic mean concentration was calculated for each chemical using the detected concentration(s), and one-half the sample quantitation limit (SQL) for nondetect(s). Duplicate samples for a given sampling point were also averaged in this manner if a chemical was detected in only one sample of a duplicate pair

Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed. Duplicate pairs were counted as a single result for calculation of the frequency of detection.

The minimum and maximum sample quantitation limits were identified for each analyte in each data set.

95 percent upper confidence levels on the arithmetic mean concentration were calculated in accordance with "Supplemental Guidance to RAGS: Calculating the Concentration Term" (USEPA, 1992b), assuming a log-normal distribution. This guidance states that data sets with fewer than ten samples provide poor estimates of the true mean, with the upper confidence limit (UCL) frequently being greater than the highest measured concentration. Therefore, the 95 percent UCLs on the arithmetic means were not calculated for data sets with fewer than 10 samples. The 95 percent UCL is used for evaluating exposures, as described in Subsection 9.1.3.

Summary sampling data for the surface soil, subsurface soil, groundwater, and sediment data sets for AOC 57 are presented in Tables 9-4 through 9-19. The table lists frequency of detection, range of SQLs, minimum and maximum detected concentrations, arithmetic mean concentration, and 95 percent UCL for each chemical detected.

9.1.1.3 Data Screening Procedures The procedures used for selection of CPCs, based on USEPA (1989a; 1995) guidance, are described below. The results, including reasons for selection or exclusion of CPCs, are presented in Tables 9-4 through 9-19.

The summary data for soil and groundwater were compared to concentrations of sitespecific naturally occurring inorganic analytes. The development of the background data sets for soil and groundwater are described in Appendix L. In accordance with USEPA Region I guidance, the comparison was not used to eliminate any analytes; however, maximum concentrations of analytes that were below background levels were noted on the CPC selection tables. Risks attributable to background concentrations are discussed in the uncertainty section for inorganic analytes that are determined to be risk drivers.

A screening process was conducted as described by USEPA Region I (USEPA, 1995) to focus the quantitative assessment on the most likely risk drivers. As specified by the guidance, maximum concentrations of chemicals detected in a medium were compared to RBCs derived from USEPA Region III's Risk-Based Concentration Table (USEPA,

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1999). Soil and sediment concentrations were compared to residential soil RBCs, and groundwater and surface water concentrations were compared to tap water RBCs. The RBCs published by USEPA Region III are derived for a 1×10^{-6} cancer risk level or a non-cancer hazard quotient (HQ) of 1. Per USEPA Region I guidance (USEPA, 1995), the RBCs based on noncarcinogenic effects have been adjusted for a HQ of 0.1 for the purposes of CPC selection. If the maximum concentration of an analyte exceeded the appropriate RBC, the analyte was retained as a CPC.

Analytes were also compared to ARARs. No contaminant was eliminated as a CPC if it exceeded an ARAR. In this case, the ARARs used included the USEPA screening level for lead in soil (USEPA, 1994b), and USEPA MCLs, secondary MCLs, and action limits for groundwater (USEPA, 1998).

Essential nutrients were eliminated from the risk assessment because they are unlikely to result in adverse effects at low concentrations. Chemicals considered to be essential human nutrients are calcium, magnesium, potassium, and sodium. Iron is also considered a human essential nutrient, but a USEPA Region III RBC is available for it.

RBCs and ARARs were not available for TPHC, EPH, or VPH. These contaminants were therefore considered CPCs.

The CPCs selected for surface soil, subsurface soil, groundwater, surface water, and sediment are discussed below.

SURFACE SOIL

Area 2 Industrial

CPCs selected in Area 2 industrial surface soils included arsenic, chromium, iron, manganese, and TPHC (Table 9-4). Among these CPCs, the maximum detected concentrations of chromium and iron did not exceed the background concentrations, suggesting that their presence in Area 2 industrial surface soils is not attributable to releases at the Site.

Area 2 Recreational

CPCs selected in Area 2 recreational surface soils included arsenic, iron, manganese, Aroclor-1260, TPHC, C9-C12 aliphatics and C9-C10 aromatics VPH fractions, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH fractions (Table 9-5). The maximum detected concentration of iron did not exceed the background concentration, suggesting that its presence in Area 2 recreational surface soils is not attributable to releases at the Site.

Area 3 Industrial

CPCs selected in Area 3 industrial surface soils included arsenic, iron, manganese, TPHC, C9-C12 aliphatics and C9-C10 aromatics VPH fractions, and C19-C36 aliphatics EPH fraction were also selected as CPCs (Table 9-6). The maximum detected concentration of iron did not exceed the background concentration, suggesting that its presence in Area 3 industrial surface soils is not attributable to releases at the Site.

Area 3 Recreational

CPCs selected in Area 3 recreational surface soils included arsenic, manganese, dieldrin, TPHC, C9-C12 aliphatics and C9-C10 aromatics VPH fractions, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH fractions (Table 9-7). The maximum detected concentration of manganese did not exceed the background concentration, suggesting that its presence in Area 3 recreational surface soils is not attributable to releases at the Site.

SUBSURFACE SOIL

Area 2 Industrial

CPCs selected in Area 2 industrial subsurface soils included arsenic, iron, manganese, and TPHC (Table 9-8). The maximum detected concentrations of arsenic, iron, and manganese did not exceed the background concentrations, suggesting that their presence in Area 2 industrial subsurface soils is not attributable to releases at the Site.

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Area 2 Recreational

CPCs selected in Area 2 recreational subsurface soils included aluminum, arsenic, chromium, iron, lead, manganese, dieldrin, Aroclor-1248, Aroclor-1260, and TPHC (Table 9-9). In addition C9-C12 aliphatics VPH, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH were selected as CPCs. The maximum detected concentrations of aluminum, iron, and manganese did not exceed the background concentrations, suggesting that their presence in Area 2 recreational subsurface soils is not attributable to releases at the Site.

Area 3 Industrial

CPCs selected in Area 3 industrial subsurface soils included arsenic, iron, TPHC, and C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics EPH fractions (Table 9-10). The maximum detected concentration of iron did not exceed the background concentration, suggesting that its presence in Area 3 industrial subsurface soils is not attributable to releases at the Site.

Area 3 Recreational

Arsenic is the only CPC selected in Area 3 recreational subsurface soils (Table 9-11).

GROUNDWATER

Area 2 Industrial

CPCs selected in Area 2 industrial unfiltered groundwater included aluminum and manganese (Table 9-12). The same CPCs were selected in filtered groundwater.

Area 2 Recreational

CPCs selected in Area 2 recreational unfiltered groundwater included arsenic, iron, manganese, Aroclor-1260, bis(2-ethylhexyl)phthalate, 1,2-dichloroethylene (total), tetrachloroethylene, trichloroethylene, nitrogen, and phosphate (Table 9-13). The same inorganic CPCs were selected in filtered groundwater.

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Area 3 Industrial

CPCs selected in Area 3 industrial unfiltered groundwater included aluminum, arsenic, cadmium, iron, manganese, 1,2-dichlorobenzene, 1,4-dichlorobenzene, naphthalene, carbon tetrachloride, chloroform, tetrachloroethene, nitrogen, phosphate, and C9-C10 aromatics VPH (Table 9-14). Arsenic, iron, and manganese were selected as CPCs in filtered groundwater.

Area 3 Recreational

CPCs selected in Area 3 recreational unfiltered groundwater included aluminum, arsenic, iron, manganese, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, naphthalene, tetrachloroethene, trichloroethylene, phosphate, and C5-C8 aliphatics, C9-C12 aliphatics, and C9-C10 aromatics VPH fractions (Table 9-15). Arsenic was the only CPC selected in filtered groundwater.

Sediment

Area 2 Recreational

The CPCs selected in Area 2 sediment included aluminum, arsenic, chromium, iron, lead, manganese, dieldrin, and TPHC (Table 9-16).

Area 3 Recreational

The CPCs selected in Area 3 sediment included arsenic, manganese, Aroclor-1260, C11-C22 aromatic and C19-C36 aliphatic EPH fractions, as well as C9-C10 aromatic, C9-C12 aliphatic, and C5-C8 aliphatic VPH fractions (Table 9-17). Arsenic and manganese were detected at concentrations below background.

Surface Water

Area 2 Recreational

The CPCs selected in Area 2 surface water included ten inorganics, bis(2ethylhexylphthalate), five chlorinated VOCs, TPHC, C11-C22 aromatic EPH, and C19-C36 aliphatic EPH (Table 9-18). Of the inorganics detected, arsenic, iron, and

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manganese were detected at concentrations below background.

Area 3 Recreational

The CPCs selected in Area 3 surface water included antimony, arsenic, barium, manganese, C11-C22 aromatic EPH, and C19-C36 aliphatic EPH, and C9-C10 aromatic VPH (Table 9-19). Arsenic and manganese were detected at concentrations below background.

9.1.2 Exposure Assessment

The purpose of the exposure assessment is to identify the potential pathways by which human populations may be exposed to CPCs at AOC 57, and to make quantitative estimations of those exposures. The following subsections describe the exposure assessment for the human health risk assessment at AOC 57.

9.1.2.1 Exposure Pathways. An exposure pathway generally consists of four elements:

- (1) A source and mechanism of chemical release to the environment;
- (2) A retention or transport medium for the released chemical;
- (3) A point of potential human contact with the impacted medium (i.e., the exposure point); and
- (4) A route of exposure (ingestion or dermal contact, for example) for a potential receptor.

When all four of these elements are present, an exposure pathway is considered "complete." In the risk assessment, only exposure pathways that are complete under present land use, or potentially complete under the anticipated future land use, are evaluated. The exposure pathway assessment for AOC 57 draws on information regarding the source of CPCs, fate and transport of CPCs, and information on human populations potentially exposed to CPCs in environmental media. The conceptual site model presented in Subsection 9.1 provides an overview of the potentially complete migration pathways at AOC 57. These migration pathways are evaluated in the context of current and anticipated future land use to identify potentially exposed populations,

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exposure media, and exposure routes to those exposure media.

Current and Anticipated Future Site Use

In evaluating potential human exposure pathways, exposures under both current and potential future site uses and surrounding land use conditions were evaluated. Current land use conditions were evaluated to consider possible exposures under the existing land use. Future land use conditions were considered to address exposures that may occur as a result of possible reuse of the site.

The current land use at AOC 57 may best be described as idle. The are no active military operations or land-redevelopment near AOC 57. The majority of the AOC is forested and densely vegetated, and access is difficult. There is no specific reason to visit the AOC, and there are no nuisance or curiosity attractions. The wetland area is muddy; any standing surface water is not deep enough nor aesthetically pleasing. Therefore, it is unlikely that any people would be present at, or access AOC 57 under the existing land use conditions.

The future site and surrounding land use conditions at AOC 57 were assumed to be commercial/industrial in the upland areas, and open space, recreational in the wetland areas. AOC 57 is located within an area designated for "Rail, Industrial, Trade-Related, and Open Recreational" in the Devens Reuse Plan (Vanasse Hangen Brustlin, 1994). Under commercial/industrial use, buildings could be constructed at the site, and occupational workers could be present on a full-time basis. Construction of buildings in the delineated wetland area or use of this area for anything other than open space is not realistic. However, the future use of this area could include constructing designated trails for passive recreational use (e.g., bird watching). Therefore, under the future land use, it is possible that recreational visitors and construction workers could access the wetland areas.

Future residential use of the land at AOC 57 is not a likely future land use; the Devens Reuse Plan does not include residential development of the land in the vicinity of AOC 57, and construction of residential properties in the wetland is not realistic. Nonetheless, to aid in risk management decision-making and to evaluate the need for additional actions at AOC 57, future unrestricted (i.e., residential) land use was evaluated.

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Exposure Pathways and Scenarios

Possible exposure pathways encompassing both current and future conditions are summarized in Table 9-20 and discussed below.

Soil Pathway

Industrial Use Areas. Under current and possible future land use, it is assumed that a maintenance worker could be exposed to surface soils. Although it is not likely that this receptor would occur at the site frequently under the existing land use, re-development of a nearby property could result in exposures during landscaping activities. Under possible future land use as a commercial/industrial property, occupational workers could occupy the property daily and be exposed to surface soils. In addition, an excavation worker may be exposed to surface and subsurface soils during site re-development. Unrestricted land use is evaluated by assuming that child and adult residents could be exposed to surface soil and subsurface soil. Soil exposure pathways for all receptors include incidental soil ingestion, dermal contact, and dust inhalation.

Recreational Use Areas. Although exposures at the wetland area are not expected under the current land use, exposures could occur in the future during passive recreational use. Therefore, it is assumed that an older child (ages 6 through 16) might be exposed at the wetland areas. Evaluation of possible exposures to this receptor provides a conservative assessment of risks for possible current land uses. Possible exposure pathways for this receptor include incidental ingestion and dermal contact with surface soil. Inhalation exposures to dust would be insignificant because the wetland soils are too moist and too heavily vegetated to liberate dust when agitated. It is unlikely that occupational workers who may be employed at future commercial/industrial facilities in the industrial areas would access the wetland. However, if walking pathways are constructed in the wetland areas, it is possible that an excavation worker could be exposed to soils. Unrestricted land use is evaluated by assuming that child and adult residents could be exposed to surface soil and subsurface soil. Under this assumption, excavation workers could also be exposed to surface and subsurface soils during construction of residential properties. Soil exposure pathways for residential and excavation worker receptors include incidental soil ingestion, dermal contact, and dust inhalation.

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Groundwater Pathway

Industrial Use Areas. Under current land use there is no use or exposure to groundwater associated with AOC 57. AOC 57 is not within the Zone II of a potentially productive aquifer and, therefore, is not considered a drinking water resource by the State of Massachusetts. Because Devens has a municipal water supply, any commercial/industrial properties that are constructed at AOC 57 would be supplied with municipal water. It is possible, however, that industries which require water for process operations would install a groundwater well to supply water. Workers could potentially contact the groundwater if it was used in open systems. Under this scenario, dermal contact and volatile inhalation exposures could occur. However, any volatile inhalation exposures would be insignificant (see discussion in "Air Pathway" below), and dermal contact (e.g., gloves). To provide a very conservative evaluation of possible risks associated with commercial/industrial use of groundwater, exposures associated with potable use of the groundwater (i.e., ingestion exposures) by commercial/industrial workers is evaluated.

Unrestricted land use is evaluated by assuming that residents could be exposed to groundwater via potable use. Groundwater exposure pathways for residential receptors include ingestion, dermal contact, and volatile inhalation.

Recreational Use Areas. Under current land use there is no use or exposure to groundwater associated with AOC 57. AOC 57 is not within the Zone II of a potentially productive aquifer and, therefore, is not considered a drinking water resource by the State of Massachusetts. Under possible future land use, the wetland areas would not be developed and, therefore, groundwater use and exposures would not occur. Unrestricted land use is evaluated by assuming that residents could be exposed to groundwater via potable use. Groundwater exposure pathways for residential receptors include ingestion, dermal contact, and volatile inhalation

Surface Water and Sediment Pathways

The wetland areas contain small areas of standing surface water. These surface water bodies are not suitable for swimming, and are generally not deep enough for wading in. In addition, due to the heavy vegetation and stagnancy of the water, the surface water bodies are not aesthetically pleasing. However, older children who may visit the wetland areas may be drawn to areas of standing water. Therefore, these receptors could contact

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the surface water and sediment in the wetland areas. Exposure routes to these media would include incidental ingestion and dermal contact. Construction workers would not be exposed to the surface water and sediment because they would wear protective clothing (e.g., boots and gloves) in anticipation of such exposures.

Air Pathway

Industrial and Recreational Use Areas. There are five possible exposure pathways by which current and future land use receptors could be exposed to CPCs in air: 1) soil-derived dust inhalation; 2) vapor migration from soil to ambient air; 3) vapor migration from groundwater to ambient air; 4) vapor migration from soil to indoor air; and 5) vapor migration from groundwater to indoor air.

VOCs and VPH compounds may volatilize from soil or groundwater to ambient air. Volatile migration from soil or groundwater to buildings that are constructed over the volatile contamination can result in exposures to occupants of the buildings. Due to the dilution of vapor concentrations that occurs when vapors migrate from below ground surface to open air, exposures to volatiles in ambient air are normally only a concern when volatile CPCs are detected at high concentrations in soil or groundwater. Volatile migration from groundwater is only a potential concern when the depth to groundwater is fifteen feet or less.

Groundwater at AOC 57 is located within 15 feet of the ground surface, indicating that groundwater could be a source of vapor emissions. However, a comparison of maximum detected groundwater VOC concentrations to MADEP GW-2 groundwater standards, which are protective for volatile migration from groundwater to indoor air which are protective for vapor migration to indoor air at a cancer risk level of 1×10^{-6} and a non-cancer HI of 0.2, indicates that VOCs were not detected in groundwater at concentrations that could pose a volatile migration concern (Table 9-21). As shown in Table 9-21, the maximum groundwater concentrations are generally several orders of magnitude below the GW-2 standards, indicating that risks for vapor migration to indoor air would be below 1×10^{-6} and a HQ of 0.1. Similarly, VOCs were detected in soil at low frequencies (generally only one or two samples per data set), and at low concentrations (generally less than 0.1 mg/kg). This indicates that volatile migration from soil to ambient air or air within buildings that could be constructed in the future would be insignificant. Therefore, inhalation exposures associated with volatile migration from soil and groundwater were not quantitatively evaluated.

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9.1.2.2 Estimation of Exposure. To quantitatively estimate the magnitude of exposures and the risks that may be experienced by an individual, the representative concentration of the CPC in the contact medium at each exposure point must be known or estimated. This concentration is referred to as an exposure point concentration (EPC). To develop quantitative estimates of exposure, the EPC is combined with receptor-specific variables which describe the magnitude with which the receptor comes into contact with the exposure medium.

Exposure Points

For soil and groundwater at Area 2 and Area 3, there are two exposure points for each medium: industrial use exposure points for surface soil, subsurface soil, and groundwater, and recreational use exposure points for surface soil, subsurface soil, and groundwater. The surface water and sediment have one exposure point at each area. The boundaries of each exposure point are defined by the locations of the samples included in each of the media, as listed in Tables 9-4 through 9-19 and shown in Figure 9-1.

Exposure Point Concentrations

The EPCs for surface soil, subsurface soil, surface water, and sediment are the lesser of the 95 percent UCL on the arithmetic mean concentration or the maximum detected concentration (USEPA, 1992b; 1994a). Because there were less than ten samples included in the data sets for some exposure points, 95 percent UCLs were not calculated; the EPCs for these exposure points are the maximum detected concentrations. The same EPC was used for the reasonable maximum exposure (RME) and central tendency (CT) exposure scenarios (USEPA, 1995).

Exposures to petroleum contamination in soil were evaluated using EPH and VPH data, as opposed to TPHC data. Use of EPH and VPH data permits a site-specific assessment of the petroleum-related constituents, and is consistent with the MADEP petroleum policy (MADEP, 1997). Because some soil samples collected near source areas during the 1995/1996 field program were analyzed for TPHC (the EPH/VPH methodology had not been promulgated at the time), it was necessary to convert the TPHC concentrations to EPH/VPH concentrations for development of EPCs. The TPHC data were converted to EPH/VPH by calculating the average composition of EPH/VPH in site soils (based on measured EPH/VPH concentrations), and then applying the compositional information to

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In surface water, Area 3 sediment, and groundwater, petroleum was evaluated as EPH and VPH fractions. In Area 2 sediment, petroleum contamination was evaluated as TPH using several different analytical methods. To provide a conservative assessment of potential exposures, the highest TPH concentration among the various analytical methods was used as the exposure point concentration.

For groundwater potable use, USEPA Region I guidance states that the groundwater EPC for RME conditions is the maximum concentration (USEPA, 1995).

Exposure point concentrations for soil, groundwater, surface water, and sediment are provided in Tables 9-22 through 9-37.

Exposure Estimates

Quantitative exposure estimates were derived by combining the EPCs with information describing the extent, frequency, and duration of exposure for the specific receptor. An overview of the approaches used to quantify exposures is given below, along with specific details for potential exposure pathways. The approaches to quantify exposures described in the following paragraphs are consistent with guidance provided by USEPA (1989a; 1989b; 1991; 1992d; 1994a; 1995).

The term "reasonable maximum exposure" (RME) is defined as the maximum exposure that is reasonably expected to occur at a site (USEPA, 1989). The RME is intended to place a conservative upper-bound on the potential risks, meaning that the risk estimate is unlikely to be underestimated but it may very well be overestimated. The likelihood that this RME scenario may actually occur is small, due to the combination of conservative assumptions incorporated into the scenario. The RME estimate for a given pathway is derived by combining the EPC of each chemical with reasonable maximum values describing the extent, frequency, and duration of exposure (USEPA, 1994a). The CT estimate combines the EPC with CT exposure parameters. Many of the exposure parameter values used in this assessment have been defined by USEPA (1989a; 1989b; 1991; 1994a). Both CT and RME exposures were estimated for each current and future

land use receptor exposure scenario evaluated. CT exposures were not evaluated for the unrestricted land use scenario, since decisions regarding the possible need for land use restrictions or other actions will be based on the RME risks.

The general equation for calculating chemical intake is as follows:

$$Intake = C x CR x RAF x EF x ED$$
$$BW x AT x CF$$

where:

Intake	=	daily intake averaged over the exposure period (mg/k/day)
С		concentration of the chemical in the exposure medium
		(mass/volume)
CR	=	contact rate for the medium of concern (mass/day)
RAF		relative absorption factor (unitless)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight of the hypothetically exposed individual (kg)
AT		averaging time (for carcinogens, AT = 70 years; for
		noncarcinogens, $AT = ED$)
CF	-	units conversion factor (365 days/yr)

Specific equations for each exposure scenario are provided in the risk calculation spreadsheets in Appendix N-5. For dermal uptake of soil CPCs, USEPA Region I uses USEPA draft dermal exposure guidance (USEPA, 1998), which provides quantitative dermal absorption factors for several chemicals. Dermal exposures to those chemicals (when detected) were quantitatively evaluated; dermal exposures to chemicals for which dermal absorption values are not published were not quantitatively evaluated.

Standard exposure parameters from USEPA guidance were used, where appropriate, to estimate CPC intake. Tables 9-38 presents the parameters used in current/future use, possible future use, and unrestricted future use scenarios, respectively. The parameters are discussed briefly below.

<u>Contact Rate</u>. The contact rate reflects the amount of the medium contacted per unit of time or event. For incidental ingestion of soil, the RME contact rate is 100 mg soil per day (mg/day) for the site maintenance worker, commercial/industrial worker, recreational

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child, and adult resident (USEPA, 1994a). The CT value for these receptors is 50 mg/day (USEPA, 1994a). The RME ingestion rate for the child resident is 200 mg/day, and the CT value is 100 mg/day (USEPA, 1994a). For the excavation worker, the RME and CT contact rates are 480 mg/day (USEPA, 1994a). A fraction-ingested variable can be used to account for the amount of soil ingested daily that is assumed to come from the area of concern. It is conservatively assumed that all soil ingested daily would originate at AOC 57.

For ingestion of groundwater used as residential drinking water, the ingestion rate for the RME is 2 liters per day (USEPA, 1994a). The RME ingestion of groundwater used as commercial/industrial drinking water is 1 liter per day (USEPA, 1994a).

The inhalation rate for maintenance and commercial/industrial workers is based on the short-term inhalation rate for moderate activities (1.6 m³/hour; USEPA, 1997). The inhalation rate for the excavation worker is based on the upper percentile rate outdoor activities (3.3 m³/hour; USEPA, 1997). The inhalation rate for residential receptors is based on the mean long-term inhalation rate for children (0.31 m³/hour; USEPA, 1997) or adults (0.63 m³/hour; USEPA, 1997).

The contact rate for ingestion of sediment was assumed to be ¼ the ingestion rate for soil. This value was used because the soil ingestion rate is based on the total amount of soil that is consumed in a given day from all sources (i.e., outdoor soil, indoor dust, etc). Therefore using the same soil ingestion rate to account for surface soil and sediment exposures would overestimate "soil" ingestion by two-fold. Adjustment of the sediment ingestion rate reflects the fact that more of the wetland areas are covered with soil than sediment (i.e., more wetland area is represented by soil data than by sediment data), indicating that the majority of potential exposures would be to soil than to sediment. The surface water ingestion rate was assumed to be ¼ the surface water ingestion rate for swimming (USEPA, 1997). This value reflects that fact that ingestion exposures to the small, shallow areas of surface water would only be incidental.

The contact rate for dermal exposures is calculated using the skin surface area exposed to soil and the soil adherence factor. The skin surface area for the older child trespasser is calculated as the age-averaged body surface area for hands, arms, and lower legs (surface soil and sediment) and lower legs and feet (surface water) (USEPA, 1997). The soil adherence factor for this receptor, as well as the child resident, is assumed to be 1.0 mg/cm² (USEPA, 1998). As recommended in recent USEPA guidance (USEPA, 1997;

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USEPA, 1998), the soil adherence factors for adult receptors are calculated using body part-specific dermal loading factors and skin surface areas that are selected for activities that conservatively represent the type of exposures that receptors at the site may have. Appendix N-3 provides documentation of the soil adherence factor and body surface area calculations for the receptors evaluated in this risk assessment.

<u>Relative Absorption Factor</u>. The relative oral absorption factor represents the ratio of a chemical's bioavailability (i.e., ability to be absorbed and potentially exert an effect) in an environmental matrix to its bioavailability when administered in the experimental dose-response study from which the toxicity criterion for that chemical was derived. The relative oral bioavailability factor is applied to account for the potentially reduced bioavailability of a chemical when ingested in a soil matrix, compared to when experimentally administered in a food mash, water, or a solvent medium. In keeping with the conservative nature of this assessment, a relative oral bioavailability of 100 percent (or 1.0) is assumed for all CPCs.

Dermal exposures to soil and sediment CPCs were evaluated using dermal absorption efficiency values published by USEPA (USEPA, 1998). Dermal exposures to CPCs in surface water were evaluated using permeability coefficients published by USEPA (USEPA, 1998).

<u>Exposure Frequency and Duration</u>. An exposure frequency of two times per week for 26 weeks (May-October), equal to 52 days per year for 25 years, is assumed for the site maintenance worker. It is assumed that the maintenance worker spends 8 hours per day on the days working at the Site. Contact with the soil is negligible when the ground is frozen or snow-covered. An exposure rate of less than five days per week accounts for work performed in other areas of the facility.

Commercial/industrial workers are assumed to work 5 days per week, 50 weeks per year for 25 years, but be exposed to soils for only 30 weeks per year (equal to 150 days per year) when the ground is not frozen (USEPA, 1994a). The CT exposure frequency and duration are assumed to be one-half the RME values.

Since AOC 57 is not located near any active facilities at Devens (e.g., schools, houses), it is unlikely that trespassing occurs at the site frequently. However, future recreational visitors may access the site more regularly. Therefore, an RME exposure frequency of two days per week for 26 weeks (May-October), equal to 52 days per year, is assumed for

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the recreational child exposure to surface soil. The CT value is assumed to be one-half the RME value. A recreational child ages 6 through 16 is assumed to occur at the site for 11 years (equivalent to the duration of age 6 through 16) for the RME and CT scenarios.

The excavation worker is assumed to work five days per week (equivalent to a frequency of 250 days per year) over a 26 week period (one-half a year).

<u>Body Weight</u>. The body weight used for adult receptors is 70 kilograms (kg), which represents the standard default value for adult body weight (USEPA, 1994a). The ageadjusted body weight for the child trespasser, assumed to be 6 through 16 years of age, is 61 kg (USEPA, 1997).

<u>Averaging Time.</u> The averaging time for lifetime exposure, used for developing intake to evaluate carcinogenic risk, is 70 years. Averaging time for noncarcinogenic risk is equal to the exposure duration (USEPA, 1989).

9.1.3 Toxicity Assessment

The objective of the toxicity assessment is to define the relationship between the dose of a substance and the likelihood that a toxic effect, either carcinogenic or noncarcinogenic, will result from exposure to that substance. This is performed by identifying the potential adverse health effects associated with exposure to a substance, and then quantifying those dose-response relationships. Potential adverse health effects associated with each CPC evaluated in this risk assessment are summarized in short toxicity profiles provided in Appendix N-4. Dose-response information for the CPCs, which is used in the risk assessment to estimate the likelihood of adverse effects as a function of human exposure to the CPCs, is presented in Tables 9-39 through 9-43.

There are two types of dose-response values used in this risk assessment: cancer slope factors (CSFs) and reference doses (RfDs). USEPA has derived CSFs and RfDs to evaluate carcinogenic risks and noncarcinogenic (systemic) effects, respectively. The definitions of CSFs and RfDs, as stated in USEPA guidance are:

• Cancer Slope Factor - a plausible upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime exposure to a particular concentration of a

potential carcinogen (USEPA Class A or B carcinogens) (USEPA, 1989a).

- Chronic Reference Dose an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (e.g., as a Superfund program guideline, seven years to a lifetime) (USEPA, 1989a). The chronic RfD is used to estimate toxicity to all receptors occurring at a site for more than seven years.
- Subchronic Reference Dose an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a portion of a lifetime (e.g., as a Superfund program guideline, two weeks to seven years) (USEPA, 1989a). The subchronic RfD is used to estimate toxicity to all receptors occurring at a site for between two-weeks and seven years (e.g., excavation worker).

In addition, because the toxicity and/or carcinogenicity of a compound can depend on the route of exposure (e.g., oral or inhalation), unique dose-response values (e.g., CSFs and RfDs) have been developed for the oral and inhalation exposure routes. Oral and inhalation CSFs for the CPCs associated with AOC 57 are presented in Tables 9-39 and 9-40, respectively. Oral and inhalation RfDs for the CPCs associated with AOC 57 are presented in Tables 9-41 and 9-42, respectively.

Inhalation RfDs are not available for many CPCs. HEAST and IRIS do, however, list reference concentrations for a number of the CPCs. Inhalation reference concentrations were converted to inhalation reference doses as needed (Table 9-42).

The methodology used to develop dermal toxicity values is obtained from Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance (USEPA, 1998). The oral toxicity value is adjusted from administered dose to absorbed dose, if necessary. The absorption efficiency of a particular compound is used to calculate an RfD based on absorbed dose. For example, if the RfD based on administered dose was 20 mg/kg/day, and the absorption efficiency in the study that is the basis of the RfD was 10 percent, then: 20 mg/kg/day x 0.10 = 2 mg/kg/day. Therefore, the adjusted RfD is 2 mg/kg/day. This adjusted value is the dermal reference dose (RfD_{derm}). Similarly, the dermal cancer

slope factor (CSF_{derm}) is obtained by adjusting the oral CSF. For example: if the CSF based on administered dose was 1.6 $(mg/kg/day)^{-1}$, and the absorption efficiency in the study that is the basis of the CSF is 20 percent, then: 1.6 $(mg/kg/day)^{-1}/0.20 = 8$ $(mg/kg/day)^{-1}$. This adjusted value is the CSF_{derm}.

The oral absorption efficiencies used to derive dermal dose response values for specific compounds were obtained from USEPA guidance (USEPA, 1998). If the absorption efficiency for a compound was not listed, then a dermal dose-response value was not calculated. If there was more than one value listed for an individual compound, the value for oral absorption from the diet was chosen; if there was not a value listed for absorption from the diet, then the most conservative published value was used. Dermal dose-response values are presented in Table 9-43.

Source of Dose-Response Values

The primary source for dose-response values is the USEPA Integrated Risk Information System (IRIS) (USEPA, 1998). If no information is found in IRIS, the USEPA Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997c) are used. If appropriate dose-response values are not available from either of these two sources, other USEPA sources are consulted (e.g., the USEPA National Center for Environmental Assessment).

No USEPA-approved toxicity values are available for TPHC, EPH, or VPH. However, the "Characterizing Risks posed by Petroleum Contaminated Sites: Implementation of MADEP VPH/EPH Approach" (MADEP, 1997) recommends the application of Reference Doses for indicator compounds to various fractions of petroleum products analyzed for by the EPH and VPH methods as a means of assessing risks associated with media that contain petroleum. These RfDs were used to estimate the risks associated with each EPH/VPH fraction.

Because no chemical speciation analyses were performed for chromium in environmental media at AOC 57, chromium was evaluated using dose-response values for hexavalent chromium. This provides a conservative assessment of potential toxicity and risks because hexavalent chromium is considered to be the more toxic (and potentially carcinogenic) form of inorganic chromium.

USEPA has published cancer slope factors for PCBs that are based on a tiered approach that considers risks and persistence by various exposure pathways (USEPA, 1999). The three tiers identified by USEPA are: high risk and persistence, low risk and persistence,

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and lowest risk and persistence. Within each of these tiers, upper bound and centralestimate slope factors have been published. The slope factors are to be used for oral, dermal, and inhalation exposures. The high risk/high persistence slope factors are used for soil and sediment because exposures to these media are evaluated for ingestion, particulate inhalation (soil only), and dermal contact with the application of an absorption factor. These slope factors are also chosen for groundwater and surface water because PCBs detected in these media are unlikely to be dissolved in the water, but are more likely to be relatively insoluble and adsorbed to suspended solids or particulates in the water sample. The upper bound slope factors are chosen in order to provide an evaluation that is unlikely to underestimate risks for potential exposures to PCBs.

9.1.4 Risk Characterization

In this final step of the risk assessment process, the exposure and toxicity information are integrated to develop both quantitative and qualitative evaluations of risk. To quantitatively assess risks associated with CPCs in an environmental medium, the average daily intakes calculated in the Exposure Assessment are combined with the doseresponse criteria presented in the Toxicity Assessment. The methodology used to quantitatively assess risks is described below.

9.1.4.1 Risk Characterization Methods. The potential risks to individuals from exposure to carcinogenic and noncarcinogenic CPCs is evaluated in accordance with USEPA (1989) guidance.

Cancer Risks

For exposures to a chemical associated with carcinogenic effects, an individual upper bound excess lifetime cancer risk (ELCR) is calculated by multiplying the estimated daily CPC intake by the relevant CSF:

ELCR = Intake (mg/kg/day) x CSF (mg/kg/day)⁻¹

The resulting risk estimate is an upper-bound estimate of the probability of developing cancer as a result of exposure to the potential carcinogen over a 70-year lifetime under the specified exposure conditions. A risk level of 1×10^{-6} , for example, represents an upper bound probability of one in one million that an individual will develop cancer. The upper bound cancer risk estimates provide estimates of the upper limits of risk, and the risk

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estimates produced are likely to be greater than the 99th percentile of risks faced by actual receptors (USEPA 1989a). This incremental lifetime risk is over and above what is considered an individual's background chances of developing cancer. In the U.S., approximately one in three people develop cancer during their lifetime (American Cancer Society, 1997). To assess the upper bound individual ELCRs associated with simultaneous exposure to all carcinogenic chemicals of concern, the risks derived from the individual chemicals are summed within each exposure pathway. This approach is consistent with the USEPA's guidelines for evaluating the toxic effects of chemical mixtures (USEPA 1989b). In addition, to evaluate total cancer risk to a receptor population, cancer risks are summed for each medium to which a receptor may be exposed.

The relative significance of carcinogenic risk estimates is evaluated by comparison to a range of 10^{-6} to 10^{-4} established in the National Contingency Plan (USEPA, 1990). USEPA's guidelines state that when the total incremental carcinogenic risk for an individual resulting from exposure at a hazardous waste site is within the range of 10^{-6} to 10^{-4} , the decision about whether a response action is required is based on site-specific factors.

Non-Cancer Risks

Unlike carcinogenic effects, noncarcinogenic effects are not expressed as incidence probabilities. Rather, potential noncarcinogenic effects are evaluated by means of calculating hazard quotients (HQs) and hazard indexes (HIs). To assess effects associated with noncarcinogenic exposures, the ratio of the daily intake to the RfD is calculated by dividing the intake for each noncarcinogenic CPC by the RfD for that CPC to derive an HQ:

HQ = Intake (mg/kg/day) / RfD (mg/kg/day)

In general, HQs that are less than 1 indicate that the associated exposure is not likely to result in any adverse health effects, whereas HQs greater than 1 indicate a greater likelihood of adverse health effects. The effects from simultaneous exposures to all CPCs were calculated by summing the individual HQs within each exposure pathway. This sum, the screening HI, serves the same function for exposures to multiple CPCs as the HQ does for exposure to an individual compound. In addition, to evaluate total non-cancer risk to a receptor population, screening HIs are summed for each medium to which

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a receptor may be exposed.

Screening HIs for both RME and CT exposures are compared to a target level of 1 established by USEPA. HIs greater than 1 indicate the potential for the occurrence of adverse health effects. However, a conclusion should not be categorically drawn that all screening HIs greater than 1 are unacceptable. If the individual CPCs effect different target organs or work through different toxicological mechanisms of action, then an HI of greater than 1 does not indicate that threshold effect levels have been reached. In cases where a screening HI is greater than 1, the CPCs are segregated by target organ/critical effect (e.g., liver, skin, etc.) and the HQs for each group of CPCs may be summed to determine if the target organ-specific HI is greater than 1 (USEPA, 1989a).

Consistent with USEPA guidance (USEPA, 1989), a determination of whether the risks for exposures to COCs in site media are additive was performed by segregating the HI according to the target organs or organ systems that each COC effects. A determination of whether risks for multiple COCs are additive was made by examining the target organs that each COC potentially exerts adverse effects on. The risks for COCs that affect the same target organ(s) are considered to be additive. For receptor scenarios in which the screening HI values exceeded the USEPA threshold HI of 1, the target organ-specific HIs were used to evaluate the potential for the occurrence of adverse health effects. The HI segregation is documented in Appendix N-6.

9.1.4.2 Risk Characterization Results. The risk calculations are presented in Appendix N-5. The risk estimates are summarized in Table 9-44, and are discussed below. Target organ-specific HIs are presented in Appendix N-6.

Area 2 - Industrial Area

Current Land Use

Risks associated with the current site use were evaluated for a maintenance worker potentially exposed to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation. The RME cancer risk for the maintenance worker is 2×10^{-6} , which is within the USEPA cancer risk range of 1×10^{-6} to 1×10^{-4} . The cancer risk is attributable to arsenic. The RME non-cancer risk is a screening HI of 0.04, which is below the USEPA threshold HI of 1. The CT cancer and non-cancer risks are 2×10^{-7} and 0.01, respectively.

Possible Future Land Use

Future land use was assumed to be commercial/industrial, based on the Devens Reuse Plan. Therefore, risks associated with future site use were evaluated for a commercial industrial worker potentially exposed to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation, and groundwater via potable use (i.e., ingestion). A construction worker potentially exposed to surface and subsurface soil via incidental ingestion, dermal contact, and particulate inhalation was also evaluated.

There were no cancer risks associated with ingestion of groundwater because there were no carcinogenic CPCs detected in Area 2 industrial groundwater. The non-cancer RME risk for commercial/industrial potable use of groundwater is a screening HI of 0.07, which is below the USEPA threshold HI of 1. The RME cancer risk for commercial/industrial worker exposure to surface soil is $7x10^{-6}$ which is within the USEPA cancer risk range of $1x10^{-6}$ and $1x10^{-4}$. The non-cancer RME risk for surface soil is a screening HI of 0.1, which is below the USEPA threshold limit of 1. The total noncancer RME risk for exposure to surface soil and groundwater is a screening HI of 0.2, which is below the USEPA threshold of 1. The CT cancer and non-cancer combined risks for surface soil and groundwater for the commercial/industrial worker are $1x10^{-6}$ and 0.1, respectively.

For the construction worker, the total RME cancer risks for surface soil $(1x10^{-6})$ and subsurface soil $(6x10^{-7})$ are within the USEPA acceptable cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. The cancer risk is attributable to arsenic. The total non-cancer RME screening HIs for surface soil (0.5) and subsurface soil (0.2) are below the USEPA threshold of 1. The CT cancer risk is below the USEPA cancer risk range, and the CT non-cancer screening HI is below the threshold HI of 1.

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the industrial (upland) portion of Area 2, unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident and child resident cancer risks for surface soil and subsurface soil are within the USEPA cancer risk range. The total receptor RME cancer risk for exposure to surface soil and subsurface soil is $4x10^{-5}$, which is within the USEPA risk range of $1x10^{-6}$ to $1x10^{-4}$. Cancer risks are attributable to arsenic. Cancer risks associated with ingestion

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of groundwater were not evaluated because there were no carcinogenic CPCs detected in Area 2 industrial groundwater.

The total RME adult resident non-cancer screening HI for exposure to surface soil (0.1) and groundwater (0.2) is 0.3, which is below the threshold HI of 1 set forth by the USEPA. The RME child resident non-cancer screening HI for surface soil and subsurface soil is 2; the risk is primarily associated with surface soil, which has a screening HI of 2. However, as shown in Appendix N-6, Table 5, no target organ-specific HI values exceed 1. The highest target organ HI values are for effects to the kidney (HI = 1) and to the skin (HI = 0.7). Based on this evaluation, non-cancer risks to the child resident do not exceed the USEPA threshold HI of 1.

This evaluation indicates that risks associated with the current, foreseeable future, and future unrestricted land uses at AOC 57 Area 2 – Industrial (upland) do not exceed USEPA risk limits.

Area 2 – Recreational Area

Current/Future Land Use

Risks associated with the current and future site use were evaluated for an older child (ages 6 through 16) potentially exposed to surface soil, surface water, and sediment via incidental ingestion and dermal contact. The RME cancer risk is 5×10^{-5} , which is within the USEPA cancer risk range of 1×10^{-6} and 1×10^{-4} . The RME non-cancer risk is a screening HI of 1, which does not exceed allowable USEPA HI threshold of 1. The CT cancer and non-cancer risks are 2×10^{-5} and a screening HI of 0.7, respectively. Cancer and non-cancer risks are primarily associated with arsenic and Aroclor-1260 in surface soil and sediment (Appendix N-6, Table 6).

Possible Future Land Use

Possible future land use may include construction of walkways in the wetland areas. Therefore, risks for the future land use are evaluated for a construction worker, as well as being represented by the risks for the current/future recreational child.

The RME cancer risks for the construction worker are within the USEPA acceptable cancer risk range for both surface soil $(3x10^{-6})$ and subsurface soil $(3x10^{-6})$; the total cancer risk for exposure to both media is $6x10^{-6}$. The CT cancer risk for exposures to both surface soil and subsurface soil is $2x10^{-6}$. The cancer risks for this receptor are

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primarily attributable to arsenic.

The RME and CT non-cancer screening HIs for subsurface soil exceed a HI of one (HI of 3), and the RME and CT screening HIs for surface soil are equal to 1. In addition, the EPC for lead (5,060 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg. As shown in Appendix N-6, Table 7, HIs based on target organ effects are at or below 1 for all organs/systems except the immune system. The HI for effects to the immune system is a HI of 2, and is primarily attributable to Aroclor-1260 in subsurface soil (HQ=2).

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the recreational (wetland) portion of Area 2 (e.g., placement of land-use restrictions on the site), unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident cancer risk for combined exposures to surface soil and subsurface soil is $4x10^{-5}$ and the RME child resident cancer risk for combined exposures to surface soil and subsurface soil is $1x10^{-4}$. The total resident cancer risk for exposure to soil is $1x10^{-4}$, which does not exceed the USEPA risk range of $1x10^{-6}$ to $1x10^{-4}$. Cancer risks are contributed equally by arsenic and Aroclor-1260 in surface soil and subsurface soil (Appendix N-6, Tables 8 and 9). The RME cancer risk for ingestion of groundwater is $1x10^{-3}$, which is above the USEPA cancer range of $1x10^{-6}$ to $1x10^{-4}$. This risk is attributable to arsenic; cancer risks for other CPCs do not exceed $1x10^{-4}$ (Appendix N-6, Table 8).

The RME adult resident non-cancer risk for surface soil and subsurface soil (combined) is a screening HI of 1. However, the child resident non-cancer risk for surface soil is a screening HI of 4, and the screening HI for subsurface soil is 19. In addition, the EPC for lead (5,060 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg. Target organ-specific HIs for the skin, GI tract, immune system, an kidney exceed one, indicating an increased risk of possible adverse health effects to these organs and organ systems. The CPCs associated with these non-cancer risks include arsenic, chromium, aroclor-1260, and C11-C22 aromatic EPH (Appendix N-6, Table 9). The RME adult resident non-cancer screening HI for groundwater (7) exceeds the USEPA threshold HI of 1. The only target organ-specific HI that exceeds 1 is for the skin, and is attributable to

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arsenic in groundwater (Appendix N-6, Table 8).

This evaluation indicates that risks associated with current and possible future recreational uses of the Area 2 wetland are within USEPA acceptable limits. However, risks associated with possible future subsurface soil excavation in the Area 2 wetland are above a HI of 1, due to risks from Aroclor-1260. Risks associated with future unrestricted use of the Area 2 wetland exceed the USEPA acceptable cancer risk range for groundwater, and non-cancer risks exceed a HI of 1 for exposures to arsenic, aroclor-1260, chromium, and C11-C22 aromatic EPH. In addition, the EPC for lead (5,060 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg.

Area 3 – Industrial Area

Current Land Use

Risks associated with the current site use were evaluated for a maintenance worker potentially exposed to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation. The RME cancer risk for the maintenance worker is 4×10^{-6} , which is within the USEPA cancer risk range of 1×10^{-6} to 1×10^{-4} . The RME non-cancer risk is a HI of 0.03, which is below the USEPA threshold HI of 1. The CT cancer and non-cancer risks are 3×10^{-7} and 0.008, respectively.

Possible Future Land Use

Future land use was assumed to be commercial/industrial, based on the Devens Site Redevelopment Plan. Therefore, risks associated with future site use were evaluated for a commercial industrial worker potentially exposed to groundwater via potable use, and to surface soil via incidental soil ingestion, dermal contact, and particulate inhalation. Risks were also evaluated for a construction worker potentially exposed to surface and subsurface soil via incidental ingestion, dermal contact, and particulate inhalation.

The RME cancer risk for the commercial/industrial worker is 1×10^{-5} for surface soil exposures, which is within the USEPA cancer risk range of 1×10^{-6} and 1×10^{-4} . The RME cancer risk for groundwater is 2×10^{-4} , which exceeds the USEPA cancer risk range. Cancer risks for soil and groundwater are attributable to arsenic; other potentially carcinogenic CPCs are associated with cancer risks below 1×10^{-5} (Appendix N-6, Table 11). The RME non-cancer screening HI is 0.1 for surface soil and 2 for groundwater. Although the RME non-cancer screening HI for groundwater exceeds the USEPA threshold HI of 1, HIs based on target organ effects do not exceed a HI of 1 (Appendix N-

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6, Table 11). The CT cancer and non-cancer risks for combined exposure to surface soil and groundwater is 5×10^{-5} and a screening HI of 2, respectively; the target organ-specific HI does not exceed 1.

For the construction worker, the total RME cancer risks to surface soil $(2x10^{-6})$ and subsurface soil $(6x10^{-7})$ are within the USEPA cancer risk range of $1x10^{-6}$ to $1x10^{-4}$. The total RME screening HI of 1 for combined exposure to surface soil (HI=0.8) and subsurface soil (HI=0.2) does not exceed the USEPA threshold of 1. The CT cancer risk for combined exposure to surface and subsurface soil is $1x10^{-6}$ and the screening HI is 1.

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the industrial (upland) portion of Area 3, unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

RME adult resident and child resident cancer risks for combined exposures to surface soil and subsurface soil are 1×10^{-5} and 5×10^{-5} , respectively, and the total resident cancer risk for exposure to soil is 6×10^{-5} , which is within the USEPA range of 1×10^{-6} to 1×10^{-4} . Arsenic is the principal contributor to cancer risk associated with soil. The resident cancer risk associated with ingestion of groundwater is 6×10^{-4} , which exceeds the USEPA cancer risk range. The principal risk contributor is arsenic; other potentially carcinogenic CPCs in groundwater are associated with cancer risks below 1×10^{-5} .

The RME adult resident and child resident non-cancer screening HIs for combined exposure to surface soil and subsurface soil are 0.1 and 1, respectively, which do not exceed the USEPA threshold HI of 1. The HI for ingestion of groundwater is 5; the HI for effects to the skin (due to arsenic) is 3 (Appendix N-6, Table 13).

This evaluation indicates that risks associated with current, possible future, and future unrestricted land use exposures to the Area 3 upland (industrial) soils are within the USEPA acceptable risk limits. Cancer and non-cancer risks associated with potable use of groundwater in the upland portion of Area 3 exceed the USEPA risk limits due to arsenic.

<u>Area 3 – Recreational Area</u>

Current/Future Land Use

Risks associated with the current and future site use were evaluated for an older child (ages 6 through 16) potentially exposed to surface soil, surface water, and sediment via incidental ingestion and dermal contact. The RME cancer risk for exposure to all media is 2×10^{-5} , which is within the USEPA cancer risk range of 1×10^{-6} and 1×10^{-4} . The RME non-cancer screening HI is 0.7, which is below the USEPA threshold HI threshold of 1. Cancer risks are primarily contributed by arsenic in all media. Non-cancer risks are primarily contributed by arsenic in soil, C11-C22 aromatic EPH in soil, and aroclor-1260 in sediment (Appendix N-6, Table 15). The CT cancer and non-cancer risks are 8×10^{-6} and 0.3, respectively.

The sediment EPC for lead (410 mg/kg) exceeds the USEPA residential screening value for lead of 400 mg/kg. However, exposures to sediment are not analogous to exposures to surface soil in a residential yard. Therefore, given the low lead concentration with respect to the screening value, and the lower exposure potential associated with sediment in the wetland, this lead concentration is not interpreted to pose a risk to the recreational child.

Possible Future Land Use

Possible future land use may include construction of walkways in the wetland areas. Therefore, risks for the future land use are evaluated for a construction worker, as well as being represented by the risks for the current/future recreational child.

The RME cancer risks for the construction worker are within the USEPA acceptable cancer risk range for both surface soil (1×10^{-6}) and subsurface soil (1×10^{-6}) . The RME non-cancer risks for combined exposures to surface soil (screening HI=0.6) and subsurface soil (screening HI=0.4) is below a the USEPA threshold HI of 1. The CT cancer and non-cancer risks are approximately the same as the RME cancer and non-cancer risks.

Unrestricted Future Land Use

To aid in risk management decision-making and to evaluate the need for additional actions in the recreational (wetland) portion of Area 3, unrestricted future land use was evaluated. Risks associated with unrestricted land use were evaluated for residential exposures to surface soil, subsurface soil, and groundwater.

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RME adult resident and child resident cancer risks for combined exposures to surface soil and subsurface soil are 2×10^{-5} and 6×10^{-5} , respectively, and the total resident cancer risk for exposure to soil is 8×10^{-5} , which is within the USEPA range of 1×10^{-6} to 1×10^{-4} . Risks are primarily associated with arsenic. The RME cancer risk for ingestion of groundwater is 1×10^{-3} , which is above the USEPA cancer range of 1×10^{-6} to 1×10^{-4} . The principal risk contributor is arsenic; cancer risks calculated for other potentially carcinogenic CPCs are below 1×10^{-5} .

The RME adult resident non-cancer HI for combined exposure to surface soil and subsurface soil is 0.3. (0.2). The adult resident screening HI for groundwater is 8, which exceeds the USEPA threshold HI of 1. The target organ-specific HI for effects to the skin (due to arsenic) is 8; HIs for other CPCs and target organs are below 1 (Appendix N-6, Table 17).

The RME child resident non-cancer screening HI for combined exposures to surface soil (HI=3) and subsurface soil (HI=0.7) is 4, which exceeds the USEPA threshold HI of 1. The target organ HI for effects to the kidney is 2 (due to C11-C22 aromatic EPH in subsurface soil), indicating an increased potential for adverse health effects (Appendix N-6, Table 18).

This evaluation indicates that risks associated with current and possible future recreational uses of the Area 3 recreational reuse area (wetland) are within USEPA acceptable limits. Risks associated with possible future excavation in the Area 3 recreational area are also within USEPA acceptable limits. Risks associated with future unrestricted use of the Area 3 recreational area (wetland) exceed the USEPA acceptable cancer risk range for groundwater (due to arsenic) and exceed a target organ-specific HI of 1 for soils (due to C11-C22 aromatic EPH) and groundwater (due to arsenic).

9.1.5 Evaluation of Uncertainty

The interpretation of risk estimates is subject to a number of uncertainties as a result of assumptions inherent in risk assessment. All quantitative estimates of risk are based on numerous assumptions, most intended to be protective of human health (i.e., conservative). As such, risk estimates are not truly probabilistic estimates of risk, but rather conditional estimates given a series of conservative assumptions about exposure and toxicity.

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In general, sources of uncertainty are categorized into site-specific factors (e.g., variability in analytical data, modeling results, and exposure parameter assumptions) and general factors that affect most risk assessments equally, such as toxicity information. Toxicity information for many chemicals is very limited, leading to varying degrees of uncertainty associated with calculated toxicity values. Sources of uncertainty for calculating toxicity factors include extrapolation from short-term to long-term exposures, amount of data (e.g., number of studies) supporting the toxicity factors, consistency of different studies for the same chemical, and responses of various species to equivalent doses. The general uncertainties that affect most risk assessments, and the direction of their potential effects on the risk assessment results (e.g., to over- or under-estimate risks) for AOC 57 are summarized in Table 9-45. Site-specific uncertainties that have the greatest potential effect on the results of this risk assessment are discussed below.

Background Conditions

Arsenic was a substantial contributor to cancer risk in soil and groundwater, and noncancer risk in groundwater. The presence of arsenic in environmental media at AOC 57 is due to its natural occurrence; arsenic is a naturally occurring element in soil and groundwater throughout New England, and there is no evidence indicating that arseniccontaining materials were disposed of at AOC 57. The levels of arsenic in groundwater at AOC 57 are generally elevated with respect to local background conditions because the anoxic conditions in soils at AOC 57 (created in part by the biotic degradation of petroleum) may have liberated naturally-occurring arsenic from the soil, whereupon it has leached to the groundwater.

The Devens background values for arsenic in groundwater and soil are 10.5 ug/L and 19 mg/kg, respectively. These concentrations are associated with residential land use cancer risks of $2x10^{-4}$ in groundwater and $3x10^{-5}$ in soil, and residential land use non-cancer risks of an HQ of 1 in groundwater and 0.3 in soil. The Federal drinking water maximum contaminant limit (MCL) for arsenic is 50 ug/L, a concentration that is associated with a cancer risk of $9x10^{-4}$ and HI of 5. Therefore, both the Devens groundwater background value and Federal MCL are associated with cancer risks that exceed the USEPA Superfund risk range. For comparison, the cancer risks associated with potential exposures to arsenic in groundwater at AOC 57 ranged from $7x10^{-4}$ (Area 3 industrial portion) to $1x10^{-3}$ (Area 2 and Area 3 wetland portions), and the HIs ranged from 3 to 8. The cancer risks associated with potential exposures to arsenic in soil at AOC 57 were

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generally approximately 5×10^{-5} . The soil and groundwater risk values for AOC 57 compare closely to the risks associated with the Devens background concentrations and/or the Federal MCL; this information should be considered when making risk management decisions about the site.

Exposure Assessment

The most substantial uncertainty affecting the results of this risk assessment is associated with the basis of the exposure point concentrations. Although a large number of samples have been collected in the various media at AOC 57, and the boundaries of the site-related contamination have been appropriately established, the segregation of the site by upland (industrial) and wetland (recreational) portions, and surface and subsurface soils, has resulted in many of the exposure points having fewer than 10 samples. Consequently, the EPCs for those exposure points are the maximum detected concentrations (USEPA indicates that the 95 percent UCL should not be used when there are fewer than 10 samples in the data set). In other areas, the EPCs are strongly influenced by the concentration to be the best estimate of the EPC when there are fewer than 10 samples, it is likely that risks based on the maximum concentration are overestimated.

At the Area 2 recreational area, risks associated with exposures to subsurface soils were above an HI of 1 for the construction worker, and the HI for surface soil was equal to an HI of 1 for the construction worker and recreational child. The principal risk contributor in these media is Aroclor-1260. Aroclor-1260 was detected in 4 out of 12 subsurface soils, and 8 out of 11 surface soils. However, the concentrations associated with three of the samples (57E-95-15X, 16X, and 12X) were approximately one order of magnitude higher than concentrations in other samples. These three samples are located at the base of Area 2 soil removal excavation and together represent only a small portion of the site. PCB concentrations throughout the remainder of the site would not pose a non-cancer risk above an HI of 1 for the construction worker.

Another substantial uncertainty associated with this risk assessment is associated with the assumed use of groundwater as a potable water source. As discussed previously, groundwater beneath AOC 57 is not considered a potable water resource by the State of Massachusetts. Given that there is an existing potable water distribution system at Devens, any future development at AOC 57 would likely use the municipal water at Devens as the potable water source. Therefore, evaluation of exposures to groundwater

as potable water represents a theoretical scenario that is most useful for evaluating the possible need for land use restrictions at the site.

If AOC 57 groundwater was used as a source of industrial process water, workers would not be ingesting the water. Any contact that occurred with the water would be incidental, and most likely only involve dermal contact. Since arsenic, which is the primary riskcontributing CPC in groundwater, does not readily absorb through the skin from water, it is unlikely that workers would be at risk from using AOC 57 groundwater as process water.

Toxicity Assessment

In accordance with USEPA Region I risk assessment guidance, dose-response values were obtained from USEPA-approved sources, including IRIS, HEAST, and NCEA. CPCs for which dose-response values were not published in these sources and for which potentially complete exposure pathways exist include arsenic, aroclor-1260, and dieldrin (inhalation RfDs), and benzo(k)flouranthene (oral RfD). Although an RfD is not published for lead, lead was evaluated using the Office of Solid Waste and Emergency Response (OSWER) residential soil screening value. In addition, NCEA publishes RfDs for iron and copper; however, those RfDs are not based on risk of adverse health effects and, therefore, are not appropriate for use in this risk assessment.

In accordance with risk characterization methodology published by the MADEP in "Guidance for Disposal Site Risk Characterization" (MADEP, 1995), inhalation RfDs may be derived for arsenic (7E-07 mg/kg/day) and aroclor-1260 (2E-05 mg/kg/day), and an oral RfD may be derived for benzo(b)flouranthene (0.03 mg/kg/day). However, incorporation of these dose-response values presented in this risk assessment does not change the conclusions of the risk assessment. If these dose response values were included in the risk characterization for the construction worker at Area 2 – recreational (wetland) subsurface soil (the exposure point and scenario with the highest inhalation non-cancer risks), the inhalation HQ for arsenic would be 0.006, and the inhalation HQ for this receptor of 0.02. If the oral RfD for benzo(b)flouranthene was used to characterize risk to the child trespasser exposed to the Area 3 wetland surface water (the only medium where benzo(b)flouranthene was detected), the HQ would be 0.0007, which does not appreciably add to the surface water HI of 0.1.

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USEPA sources do not publish dose-response values for petroleum compounds. However, because the contaminants detected at AOC 57 are primarily attributable to releases of petroleum-containing wastes, risks for potential exposures to petroleum compounds were characterized using RfDs developed by the MADEP (MADEP, 1997). This represents a conservative approach to Superfund risk characterization, because through use of these dose-response values, petroleum hydrocarbons were identified as primary (but not the only) risk contributors in Area 2 and Area 3 wetland soils. The risk management decision-making for this site should consider that risks for petroleum hydrocarbons are not based on USEPA-approved dose-response values.

Arsenic was selected as a CPC detected in all media at AOC 57. Use of the CSF for arsenic to estimate ELCRs is thought to overestimate the true risk by perhaps an order of magnitude or more (USEPA, 1998). The oral CSF for inorganic arsenic is based on dose/response data for skin cancer incidence obtained by Tseng et al. (1968). Individuals in this study were exposed to high levels of inorganic arsenic in drinking water (170 µg/mL). Arsenic exposure was approximated based on estimates of water intake. Other exposure pathways contributing to total exposure, such as ingestion of fish, livestock, and plants, were not assessed, potentially resulting in an underestimate of arsenic exposure. The oral slope factor was calculated using a model that assumes the dose/response curve is linear at low doses. Recent evidence suggests that arsenic, at low doses, may be largely detoxified by methylation, producing a non-linear dose/response curve. In the study of Tseng et al. (1968), the overwhelming of the normal detoxification pathways, coupled with an underestimate of exposure, may have resulted in an overestimate of cancer risk. These uncertainties have caused the USEPA to report that, "the uncertainties associated with ingested inorganic arsenic are such that estimates could be modified downwards as much as an order of magnitude, relative to risk estimates associated with most other carcinogens" (USEPA, 1998). Hence, for all groundwater exposure points at AOC 57, risks would not exceed the USEPA acceptable cancer risk range if this modification factor was applied to the risk estimates.

Risk Characterization

Given the uncertainties discussed in this section, it appears that the risk estimates reported in this risk assessment overestimate risks rather than underestimate risks. The primary sources of uncertainty that lend to a general overestimation of risks include:

• Influence of a small number of samples on the EPC; risks associated with

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PCBs at the Area 2 wetland (recreational reuse) are elevated due to the PCB concentrations associated with three samples at the southern end of the former soil excavation.

- Likelihood of groundwater use as drinking water
- Conservativeness of the arsenic CSF; risks for exposures to arsenic in groundwater at the Devens background concentration or Federal MCL are similar to the risks associated with groundwater at AOC 57.

9.1.6 Summary and Conclusions

Possible health risks were evaluated for the current land uses, anticipated future land uses, and unrestricted future land uses at AOC 57. Although the site is presently not used for any specific purposes, and is not located near any properties with active land uses, exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use. Therefore, the possible health risks associated with future use of the wetland area of the site were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment), as well as a construction worker (possible exposure to surface soil and subsurface soil). In addition, to aid in risk management decision-making and to determine if additional response actions may be required at AOC 57, future unrestricted land use was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil, subsurface soil, and groundwater). Since groundwater at and beneath AOC 57 is not used as a source of drinking or industrial water, and is not considered a groundwater resource by the State of Massachusetts, evaluation of potable groundwater use represents a hypothetical worst-case evaluation of potential exposures and risks.

Soil removal actions performed by the Army at Area 2 in 1994 and Area 3 in 1999 have removed the major source areas of contamination at AOC 57. The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern identified in surface soil and subsurface soil primarily included

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arsenic, iron, manganese, Aroclor-1260, and petroleum compounds such as EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations. Petroleum compounds and PCBs are interpreted to be directly associated with the release of oils and vehicle wastes to soils at the site. Inorganic constituents selected as CPCs are interpreted to be indirectly associated with the petroleum release via enhanced leaching of naturally-occurring inorganics from petroleum source area soils.

Possible health risks were quantified for carcinogenic and non-carcinogenic effects, for both reasonable maximum and central tendency exposure assumptions. Tables 9-44 and Table 10-1 present a summary of the risk estimates. The following points summarize the results of the risk assessment:

Current Land Use

• Estimated cancer and non-cancer risks for maintenance worker and child trespasser exposures at industrial (upland) and recreational (wetland) portions of Area 2 and Area 3 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.

Future Land Use

- Estimated cancer and non-cancer risks for commercial worker exposures to soil at industrial (upland) portions of Area 2 and Area 3, and commercial worker potable consumption of groundwater at Area 2, do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- Estimated cancer risks for commercial worker potable consumption of groundwater at Area 3 exceed the USEPA Superfund cancer risk range. However, due to the fact that groundwater at AOC 57 is not considered a groundwater resource by the State of Massachusetts, and the availability of public water supply at Devens, it is unlikely that groundwater beneath AOC 57 will be used as a source of potable water in the future.
- Estimated cancer and non-cancer risks for construction worker exposures to soil at industrial (upland) portions of Area 2 and Area 3, and the recreational (wetland) portion of Area 3 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- The estimated non-cancer hazard index for potential effects to the immune system exceed a HI of 1 for construction worker exposures to Area 2 wetland soil. The risks are primarily attributable to Aroclor-1260 in subsurface soil. In addition, the EPC for

lead in Area 2 wetland soil exceeds the OSWER residential screening value for soil lead.

Unrestricted Future Land Use

- Estimated cancer and non-cancer risks for child and adult resident exposures to soil and groundwater at the industrial (upland) portion of Area 2 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- Estimated cancer and non-cancer risks for child and adult resident exposures to soil at the industrial (upland) portion of Area 3 do not exceed the USEPA Superfund cancer risk range or a hazard index of 1.
- Estimated cancer risks for child and adult resident exposures to soil at the recreational (wetland) portions of Areas 2 and 3 do not exceed the USEPA Superfund cancer risk range. However, non-cancer risks to a child resident potentially exposed to soils at these areas exceed target organ-based hazard index values of 1. At the Area 2 wetland soils, the principal risk contributors are arsenic, aroclor-1260, chromium, and C11-C22 aromatic EPH. In addition, the EPC for lead in Area 2 wetland soil exceeds the OSWER residential screening value for soil lead. At the Area 3 wetland soils, the principal risk contributor is C11-C22 aromatic EPH.
- With the exception of the industrial (upland) portion of Area 2, estimated cancer and non-cancer risks for potable consumption of the groundwater at AOC 57 exceed the USEPA Superfund cancer risk range and a hazard index of 1. However, due to the fact that groundwater at AOC 57 is not considered a groundwater resource by the State of Massachusetts, and the availability of public water supply at Devens, it is unlikely that groundwater beneath AOC 57 will be used as a source of potable water in the future.

9.2 BASELINE ECOLOGICAL RISK ASSESSMENT

This Baseline Ecological Risk Assessment (BERA) evaluates actual and potential adverse effects to ecological receptors associated with exposure to contamination from AOC 57 at Devens, Massachusetts. The BERA for AOC 57 was completed in accordance with current guidance materials for BERAs at Superfund sites including the following:

• Risk Assessment Guidance for Superfund, Environmental Evaluation Manual (USEPA, 1989a);

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- Ecological Assessment of Hazardous Waste Sites, A Field and Laboratory Reference (USEPA, 1989b);
- Ecological Assessment of Superfund Sites, An Overview (USEPA, 1991a);
- Framework for Ecological Risk Assessment (USEPA, 1992a);
- USEPA Region I, New England "Risk Updates" (issued since 1992);
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA, 1997c);
- Tri-Service Procedural Guidelines for Ecological Risk Assessments, Volumes I and II (Wentsel et. al., 1996); and
- USEPA Guidelines for Ecological Risk Assessment (USEPA, 1998).

Recent risk assessment guidance including the USEPA "Eco Update" bulletins (issued since 1991) and recent publications (e.g., Maughan, 1993; Suter, 1993) were also consulted.

Historical spill or disposal activities at AOC 57 have resulted in the release of various fueland oil-related chemicals into site media. This BERA utilizes surface soil, surface water, sediment, groundwater, biological tissue, and toxicity test data to evaluate potential risks to ecological receptors.

Discussions of the general site history and layout are provided in Section 5.0, and are briefly summarized at the beginning of Section 9.0. A discussion of historical and current analytical data is provided in the contaminant assessment (Section 7.0). The AOC 57 BERA includes a Site Characterization (Subsection 9.2.1), Problem Formulation (Subsection 9.2.2), Hazard Assessment and Selection of CPCs (Subsection 9.2.3), Exposure Assessment (Subsection 9.2.4), Ecological Effects Assessment (Subsection 9.2.5), Risk Characterization (Subsection 9.2.6), Uncertainty Analysis (Subsection 9.2.7), and Summary (Subsection 9.2.8).

9.2.1 Site Characterization

AOC 57 is located between Barnum Road and Cold Spring Brook (a perennial stream)

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along the eastern boundary of the Main Post at Devens (see Figure 9-1). The area northwest of Barnum Road is primarily industrial, whereas the area southeast of Barnum Road varies from primarily forested to industrial areas bordered by forest.

Upstream portions of Cold Spring Brook (i.e., southwest of AOC 57 Area 2) are characterized by the USFWS as palustrine forested wetlands with a combination of broad-leaved deciduous and needle-leaved evergreen trees dominating the forest composition (USFWS, 1977). Northeast and downstream of AOC 57 Area 2 the brook transitions into a scrub/shrub swamp with emergent marsh characteristics (USFWS, 1977). Southeast of Cold Spring Brook, land is primarily used for agricultural purposes. The brook is a warmwater, lentic (i.e., slow-moving) stream with few channelized lotic (i.e., fast-moving) areas.

AOC 57 is divided into three primary areas of contamination: Area 1, Area 2, and Area 3 (Figures 9-1 and 5-2). Area 1 consists of a storm water outfall and eroded drainage ditch. This area does not provide adequate habitat for ecological receptors and, therefore, is not evaluated in the AOC 57 BERA. Area 2 extends along the southwestern edge of a fenced army vehicle storage yard, down a forested slope, and onto a man-made berm that extends into a floodplain swamp. Area 2 spans a lateral distance of approximately 680 feet, and differs 25 feet in elevation; for the purposes of the BERA, the upland and floodplain portions of Area 2 will be evaluated separately because of the different habitats available to ecological receptors. An erosion mat (approximately 9,400 feet² in size) covers an area of the steep slope where contaminated soils were removed in 1994.

Area 3, located approximately 650 feet northeast of Area 2, is situated between the southeastern edge of the former vehicle storage yard and the Cold Spring Brook floodplain. The slope down into the floodplain from Area 3 is gradual as this portion of Cold Spring Brook broadens out into an unchannelized scrub-shrub swamp. The distance from Area 3 to open water contiguous with Cold Spring Brook is approximately 600 feet.

In October of 1995, HLA ecologists visited AOC 57 to characterize the wetland habitats that exist at the site and to determine appropriate receptors in support of the BERA. HLA ecologists used a modified line transect method (Environmental Laboratories, 1987) to identify characteristic habitats, flora, and fauna at the site. The transects, which are shown in Figure 9-1, are approximately 160, 240, and 400 feet long from upstream (where the Cold Spring Brook channel is narrow) to downstream (where the channel broadens before the junction with Bower's Brook). Based on a review of aerial photographs and site map, the area of wetland habitat present at Area 2 and Area 3 were estimated to be approximately 2

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and 3 acres, respectively. The following paragraphs summarize the results of the qualitative survey. More information regarding the ecological survey is provided in Appendix P.

9.2.1.1 Vegetative Cover. The wetland vegetative cover types at AOC 57 are fairly well defined by topographic changes, as seen by the four zones of similar habitats encountered during the habitat characterization.

Upstream of AOC 57 Area 2 and at the AOC 57 Area 2 berm, the topographic changes are distinct and the Cold Spring Brook channel is fairly well defined. The habitats identified in this area include: floodplain forest and berm (adjacent to AOC 57), emergent marsh, scrub/shrub marsh, and upland forest (on the opposite bank from AOC 57).

The floodplain forest and berm habitats are located on the northwestern side of the Cold Spring Brook channel, and range from 0 to 2 feet above water. The canopy of the floodplain forest is dominated by white pine inter-mixed with oaks (*Quercus* sp.) and maples (*Acer* sp.). Various shrubs, including arrow-wood (*Viburnum recognitum*), highbush blueberry (*Vaccinium corymbosum*), sheep laurel (*Kalmia angustifolium*), red-osier dogwood (*Cornus stolonifera*), and winterberry (*Ilex verticillata*) were also observed in the floodplain forest. Herbaceous species observed along the edge of the stream include tussock sedge (*Carex stricta*) and various ferns (*Dryopteris* and *Osmunda* spp.). The berm is primarily vegetated with speckled alder (*Alnus rugosa*) and other shrubs also found in the floodplain forest; additional species include fetterbush (*Leucothoe racemosa*), silverberry (*Elaeagnus commutata*), and swamp rose (*Rosa palustris*).

The emergent marsh habitat, located on the southeastern side of the stream channel and in a hollowed area just upstream of the berm on the northwestern side, is dominated by broad-leaved cattails (*Typha latifolia*). The mound and pool microtopography of the emergent marsh suggest that the water table is at or near the surface throughout the year. Scattered saplings and shrubs observed in this habitat include speckled alder, common alder (*Sambucus canadensis*), swamp rose, arrow-wood, sweet gale (*Myrica gale*), winterberry, red-osier dogwood, and swamp birch (*Betula pumila*). Herbaceous species also noted in the emergent marsh include tussock sedge, meadow rue (*Thalictrum polygamum*), marsh bedstraw (*Galium palustre*), aster, purple-leaved willow herb (*Epilobium coloratum*), joe-pye weed (*Eupatorium dubium*), umbrella sedge (*Cyperus* sp.), arrow-leaved tearthumb (*Polygonum sagittatum*), jewelweed (*Impatiens capensis*), cinnamon fern (*Osmunda cinnamomea*), sphagnum moss (*Sphagnum palustre*), and sensitive fern (*Onoclea*)

sensibilis).

Just upgradient of the emergent marsh on the southeastern edge of Cold Spring Brook is a scrub/shrub marsh dominated with a fairly open canopy of red maple and white pine. Mound and pool topography, and a few snags and windthrows were observed in this habitat suggesting seasonal or year-round saturation. Shrubs found in the scrub/shrub marsh include arrow-wood, highbush blueberry, sweet gale, winterberry, sheep laurel, speckled alder, red choke cherry (*Prunus virginiana*), maleberry (*Lyonia ligustrina*), and paper birch (*Betula papyrifera*). Herbaceous species observed in this habitat include tussock sedge, interrupted fern (*Osmunda claytoniana*), water-smartweed (*Polygonum* sp.), turtle head (*Chelone glabra*), aster (*Aster novi-belgii*), New York aster (*Aster novi-belhii*), cinnamon fern, bedstraw (*Galium asprellum*), and sphagnum.

The last habitat observed on the southeastern side of Cold Spring Brook is an upland forest co-dominated by mature white pine, white oak (*Quercus alba*), and red oak (*Q. rubra*). Few beech (*Fagus grandifolia*) and several oak and pine saplings were also observed, and the open shrub canopy consisted of highbush blueberry, arrow-wood, and lowbush blueberry (*Vaccinium angustifolium*). Herbaceous species found amongst a mat of pine needles and semi-decomposed oak leaves include gold thread (*Coptis groenlandica*), partridge berry (*Mitchella repens*), interrupted fern, cinnamon fern, and lady fern (*Athyrium filix-femina*). This habitat extends up a steep slope and does not support any wetland characteristics.

Downstream of the AOC 57 (Area 2) berm, the elevational changes are more gradual and the Cold Spring Brook channel is dendritic in nature. The habitats identified downstream of the AOC 57 berm include (from northwest to southeast): Forested wetland (dominated by white pine [*Pinus strobus*]), scrub/shrub swamp, forested wetland (with sparse red maple [*Acer rubrum*]), and upland forest.

The white pine-dominated forested wetland to the northwest of Cold Spring Brook has a canopy cover of approximately 50 percent, and contains other species such as red maple, bigtooth aspen (*Populus grandidentata*), and oak. The shrub layer contains nannyberry (*Viburnum lentago*), choke cherry, arrow-wood, white oak, highbush blueberry, red-osier dogwood, and sheep laurel. The herbaceous layer in this habitat is co-dominated by tussock sedge, clubmoss (*Lycopodium* sp.), and gold thread.

Just downstream of the berm, the scrub/shrub swamp broadens and the channel of Cold

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Spring Brook becomes somewhat indistinguishable. Many of the same species observed in the upstream scrub/shrub swamp were also found in this habitat; additional shrubs observed in the downstream swamp include swamp rose, nannyberry, alder, and red-osier dogwood. The herbaceous layer in the downstream swamp is co-dominated by reed canary grass (*Phalaris arundinacea*) and tussock sedge; additional species observed include arrowhead (*Sagitaria latifolia*), yellow pond lily (*Nuphar variegatum*), pickerelweed (*Peltandra virginica*), duckweed (*Lemna minor*), and bur-reed (*Sparganium* sp.).

The forested wetland to the southeast of Cold Spring Brook has a sparse canopy cover of red maple saplings. The shrub layer is dominated by winterberry, but also contains maleberry, paper birch, highbush blueberry, and speckled alder. The herbaceous layer contains tussock sedge, interrupted fern, water-smartweed, turtle head, aster, and sphagnum. The ground surface displays some mound and pool microtopography, indicating seasonally flooded and saturated conditions.

The upland forest habitat on the southeastern side of Cold Spring Brook is an extension of the same habitat observed near to and upstream of the berm. Additional shrub and herbaceous species observed in the downstream portion of this habitat include sheep laurel, witch hazel (*Hamamelis virginiana*), nannyberry, choke cherry, clubmoss (*Lycopodium carolinianum*), and ferns (*Thelipteris* sp.).

The habitat in the upland portions of AOC 57 can best be described as disturbed uplands. This relatively flat portion of the site contains sandy, well-drained soils that have been disturbed by army activities and off-road vehicle use. The vegetation is comprised primarily of graminoids (i.e., grasses and sedges). Few trees and shrubs exist in the flatter upland portions of AOC 57; however, the portion of the site that slopes steeply down to Cold Spring Brook is forested, and eventually grades into the floodplain forest, berm, and forested wetland habitats.

9.2.1.2 Wildlife Habitat Characterization. The various wetland cover types in the vicinity of lower Cold Spring Brook are expected to provide diverse wildlife habitat. Mammals typically occurring in floodplain wetland systems in New England include mink (*Mustela vison*), river otter (*Lutra canadensis*), raccoon (*Procyon lotor*), and muskrat (*Ondatra zibethicus*). Birds common to floodplain marshes and forests include dabbling ducks (e.g., wood duck [*Aix sponsa*] and mallard [*Anas platyrhynchos*]), swamp sparrow (*Melospiza georgiana*), great blue heron (*Ardea herodias*), Virginia rail (*Rallus limicola*), and red-winged blackbird (*Agelaius phoeniceus*). Green frogs (*Rana clamitans*) have been

observed in the lower Cold Spring Brook watershed, and it is likely that the eastern painted turtle (*Chrysemys picta*) may find habitat in this area. The brook also provides suitable habitat for a wide variety of benthic and winged invertebrates; two odonates were observed during the ecological survey. The deeper portions of the brook may provide habitat for fish species such as golden shiner (*Notemigonus crysoleucas*), pumpkinseed (*Lepomis gibbossus*), and chain pickerel (*Esox niger*).

9.2.1.3 Rare, Threatened, and Endangered Species. The presence or absence of rare and endangered flora and fauna at the site is reviewed in this subsection. Under contract to the USACE, HLA developed a database of all flora and fauna known to seasonally or permanently occur at Devens (ABB-ES, 1993). Particular emphasis has been paid to rare and endangered biota. The Devens Biological and Endangered Species Baseline Study (BESBS) contains information from the Massachusetts Natural Heritage Program (MNHP, 1997), and the USFWS regarding all rare and endangered species known to occur at Devens. Additional information was also requested for more recently documented occurrences.

The BESBS has been checked for known occurrences of rare and endangered biota in the vicinity of AOC 57 and Cold Spring Brook. According to the BESBS (ABB-ES, 1993), no state or federally listed rare and endangered species occur at AOC 57 or in Cold Spring Brook. However, AOC 57 may provide suitable habitat for species that are listed by the state as species of special concern or are on the state watch list, including the wood turtle (*Clemmys insculpta*), water shrew (*Sorex palustris*), Cooper's hawk (*Accipiter cooperii*), Mystic valley amphipod (*Crangonyx aberrans*), northern leopard frog (*Rana pipiens*), great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), northern saw-whet owl (*Aegolius acadicus*), olive-sided flycatcher (*Contopus borealis*), and marsh wren (*Cistothorus palustris*).

According to the MNHP, several species have been documented as occurring within 1 mile of AOC 57. The actual occurrence of these species at the site is unknown. The following species listed by the MNHP may be found in the wooded portions of AOC 57, or in Cold Spring Brook and its floodplain: Blanding's turtle (*Emydoidea blandingii*) (threatened), eastern box turtle (*Terrapene carolina*) (special concern), wood turtle (special concern), and ovate spike-sedge (*Eleocharis obtusa* var. ovata) (endangered). The following species listed by the MNHP may be found in the upland sandy soils or disturbed portions of AOC 57: Houghton's flatsedge (*Cyperus houghtonii*) (endangered), New England blazing star (*Liatris scariosa* var. novae-angliae) (special concern), and wild senna (*Senna*

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hebecarpa) (endangered). The upland sandpiper (*Bartramia longicauda*), listed by the MNHP as endangered, is not likely to be found in the vicinity of AOC 57 as this species requires large, open grassy areas for nesting and foraging, and is generally restricted in Massachusetts to flightline areas (MNHP, 1997).

9.2.2 Problem Formulation

Problem formulation is the initial step of the BERA process whereby receptors, exposure pathways, and the assessment and measurement endpoints are selected for evaluation.

9.2.2.1 Identification of Receptors. Mammals, birds, reptiles, adult amphibians, terrestrial plants, and terrestrial invertebrates are expected to be found in the terrestrial habitats of AOC 57, including the upland portion of Area 2 and Area 3. Semi-aquatic wildlife (including wading birds, dabbling ducks, and various mammals) and aquatic receptors (including small fish, aquatic plants, benthic and pelagic macroinvertebrates, and juvenile amphibians) are expected to inhabit the scrub-shrub swamp and emergent marshes in Cold Spring Brook.

9.2.2.2 Identification of Exposure Pathways. Exposure pathways are identified for four groups of ecological receptors (wildlife, terrestrial plants, terrestrial invertebrates, and aquatic receptors). The exposure pathway includes a source of contamination, potentially contaminated media, and an exposure route. The exposure pathways from the AOC 57 contaminant source to ecological receptors are depicted in the contaminant pathway model in Figure 9-3. Dots in the model show all potential exposure pathways; those pathways that are quantitatively evaluated in the AOC 57 BERA are indicated by shading. This limitation is necessary to focus the BERA on the pathways for which: (1) contaminant exposures are the highest and most likely to occur, and (2) there are adequate data pertaining to the receptors, contaminant exposures, and toxicity for completion of risk analyses. Exposure pathways evaluated include portions of food chains (e.g., surface soil \rightarrow primary consumer \rightarrow secondary consumer \rightarrow tertiary consumer), as well as other direct and indirect exposures.

<u>Wildlife</u>. The wildlife exposure routes that are believed to contribute the highest potential contaminant exposures include incidental ingestion of site media, and ingestion of food items that have bioaccumulated and bioconcentrated contaminants from site media. Limited site-specific crayfish and fish tissue data were collected from Cold Spring Brook, and were used to evaluate exposures to wildlife that may forage in the brook. In addition, a bioaccumulation study was conducted by exposing an oligochaete (*Lumbriculus variegatus*)

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Dermal exposures to wildlife are not evaluated in the AOC 57 BERA because there are few data relating dermal exposures to toxic responses in wildlife. Dermal exposure to contaminants in surface soil may be an ecologically significant exposure pathway for adult amphibians and for young, hairless mammals in subterranean dens (e.g., juvenile muskrats); however, in general, an assumption is made that fur, feathers, or chitinous exoskeleton limit the transfer of contamination across the dermis. Furthermore, dermal exposures for amphibians are likely to be greatest during developmental aquatic life stages (i.e., free-swimming). Dermal exposures for juvenile amphibians in surface water are evaluated in the AOC 57 ERA.

Inhalation of VOCs is also not evaluated because this does not represent a complete exposure pathway for ecological receptors. The sandy soils at AOC 57 are less likely to retain VOCs from historic spills because VOCs either leached or were rapidly volatilized. Disposal activities occurred long ago, and VOC concentrations in surface soil are low enough (i.e., < $0.030 \ \mu g/g$) that toxic effects are unlikely to occur. In addition, toxicity data relating adverse effects in wildlife with inhalation exposures are limited.

Potential food chain exposures for reptiles and adult amphibians exist at AOC 57, but are not evaluated due to a lack of data relating contaminant exposures to adverse responses for these taxa.

<u>Terrestrial Plants and Invertebrates</u>. Terrestrial plants and soil invertebrates may be exposed to contamination in surface soil by direct contact, root uptake (plants), or ingestion (invertebrates) of soil.

<u>Aquatic Receptors</u>. Exposure pathways for aquatic receptors (e.g., small fish, aquatic plants, benthic and pelagic macroinvertebrates, and juvenile amphibians) at AOC 57 include direct contact with and ingestion of surface water and sediment in Cold Spring Brook. Aquatic receptors may be indirectly exposed to contaminants in groundwater as it discharges to the surface; consequently, potential risks to aquatic receptors were qualitatively evaluated by comparing groundwater concentrations with surface water concentrations.

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9.2.2.3 Identification of Endpoints. The assessment and measurement endpoints selected for the AOC 57 BERA are listed in Table 9-46. Assessment endpoints represent the ecological component to be protected, whereas the measurement endpoints approximate or provide a measure of the achievement of the assessment endpoint. The assessment endpoint selected for the AOC 57 BERA is the survival and propagation of receptor populations at AOC 57. To ensure that the AOC 57 ERA is sufficiently conservative, the lowest dose for lethal (i.e., mortality) or sublethal (i.e., growth, development, or reproduction) effects were used in the ERA as the measurement endpoint. The specific objectives of the AOC 57 BERA are to determine whether the chemical concentrations detected in surface soil, surface water, and sediment are likely to result in population decline of ecological species.

Measurements of actual toxicity and adverse effects to survival and growth were completed for two benthic invertebrates exposed to sediment, the midge (*Chironomus tentans*) and amphipod (*Hyalella azteca*), to decrease uncertainties and to measure the combined effects associated with exposure to the actual mixture of contamination present in sediment. Sitespecific toxicological data are not available for surface soil or surface water; therefore, the measurement endpoints used to gauge the likelihood of population-level effects are toxicological benchmark values based on laboratory-measured survival, growth, and reproductive effects.

9.2.3 Hazard Assessment and Selection of CPCs

The Hazard Assessment includes a review of analytical data and selection of CPCs. CPCs are the analytes detected in environmental media that are considered in the AOC 57 BERA and could present a potential risk for ecological receptors. The process for selecting CPCs is depicted in Figure 9-4.

Historical surface soil, surface water, sediment, and groundwater data (i.e., data collected before 1995) were not included in the AOC 57 BERA as they do not represent current conditions at the site. Only more current analytical data (i.e., those data collected since 1995) were utilized in the AOC 57 BERA. All of the analytical data are provided in Section 7.0 of the RI, and in Appendix M. All samples collected in 1995, 1996, and 1998 were analyzed for PAL Metals (only a subset in 1998), pesticides, PCBs, PAL SVOCs, PAL VOCs, and TPHC (except groundwater). In addition, several soil, sediment, and surface water samples in 1998 were analyzed for Surface water, groundwater, and sediment from 1995, 1996, and 1998. Samples collected in 1999 at Area 3 were analyzed primarily for

pesticides, PCBs, TPHC, EPH/VPH, and EPH/VPH target analytes.

Analytical data for AOC 57 were evaluated to determine their validity for use in the BERA. The data review process was conducted according to the methodologies described in Subsection 3.2.6.

The following data sets are evaluated in the AOC 57 BERA:

- Area 2 upland surface soil;
- Area 2 floodplain surface soil;
- Area 3 surface soil;
- Area 2 surface water (collected in Cold Spring Brook and the emergent marshes adjacent to Area 2);
- Area 2 sediment (collocated with Area 2 surface water);
- Area 3 surface water (collected from seeps in the Cold Spring Brook floodplain downgradient of Area 3);
- Area 3 sediment (collocated with Area 2 surface water);
- Area 2 groundwater, and
- Area 3 groundwater.

It should be noted that the surface water and sediment at Area 2 are hydrologically connected with Cold Spring Brook at the surface and via groundwater, whereas the surface water and sediment at Area 3 are only hydrologically connected with Cold Spring Brook via groundwater.

To select CPCs, data were screened against background data (surface soil and groundwater) or upgradient reference data (surface water and sediment) to eliminate analytes from evaluation in the AOC 57 BERA. The background surface soil and groundwater data sets consist of chemical data gathered from locations designed to establish background concentrations of inorganic analytes for Group 1A sites. The values approximately represent the 68th percentile upper bound limits (the mean values plus one standard deviation) of these chemicals (ABB-ES, 1993b). No background surface water or sediment data are available for Devens; therefore, upgradient surface water and sediment data (consisting of data collected in 1995 at sampling stations 57D-95-03X and 57D-95-08X) were used to screen CPCs instead. Sample location 57D-95-08X was collected as an upstream reference sample for the toxicity test evaluation, and sample 57D-95-03X was determined to be outside of the area of impact from AOC 57. Analytes were eliminated

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from the BERA if the maximum detected concentration was less than the background or upgradient screening value.

Because Cold Spring Brook receives effluent from various contaminant sources upstream of AOC 57, and since there were only two upgradient sample locations collected in 1995, a second "criterion" was used to select CPCs for sediment. A Master's Thesis from Northeastern University entitled "Heavy Metals in the Sediments of Massachusetts Lakes and Ponds" (Rojko, 1990) provided useful information regarding concentrations of inorganics in sediments in 100 regional lakes and ponds. Data in this study include summaries of sediment chemistry collected by MADEP for baseline and long-term surveys of ponds and lakes, as well as data collected for the MADEP Clean Lakes Programs. Rojko calculated "normal" concentrations of inorganics by averaging inorganic concentrations detected in ponds that do not have a history of anthropogenic inputs. Analytes that fall within the normal range of sediment concentrations (i.e., below the range of "elevated" sediment concentrations listed in the CPC selection tables) were excluded from the BERA. Although Cold Spring Brook does not qualify as a lake or pond, the portion of the brook in the vicinity of AOC 57 (i.e., the scrub/shrub swamp and emergent marsh) is similar to a lake or pond in that it is a depositional environment.

The essential nutrients (e.g., calcium, magnesium, potassium, and sodium) were excluded as CPCs for all media, and iron was excluded as a wildlife CPC for food-chain exposures of surface soils and sediment. Evidence suggests that there is little potential for toxic effects resulting from over-exposure to these essential nutrients. The highly controlled physiological regulatory mechanisms of these inorganics suggest that there is little, if any, potential for bioaccumulation, and available toxicity data demonstrate that high dietary intakes of these nutrients are well-tolerated (NAS, 1977; National Research Council [NRC], 1982; 1984).

All analytes detected in surface soil, surface water, sediment, and groundwater are presented in tables that include the following summary statistics: frequency of detection, range of detection limits, range of detected concentrations, and screening values. For those analytes that were retained as CPCs for the BERA, the following information is also provided: average of all concentrations, and RME and average exposure point concentrations. 95th percent UCLs were not calculated for most data sets as there are fewer than 10 samples in the data sets. A discussion of how exposure point concentrations are determined is provided in Subsection 9.2.4.1.

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The frequency of detected concentrations often shows a varying total number of samples evaluated in any one data set. This reflects the varied analytical programs that have been adopted for each of the sampling efforts that have occurred since 1995. In addition, the average of all concentrations identified for Areas 2 and 3 groundwater reflect a temporal average of monitoring well data for wells that were sampled more than once since 1995. The minimum and maximum detected concentrations reflect the true minimum and maximum detected concentrations reflect the true minimum and maximum detected concentrations during any one sampling event.

While TPHC and EPH/VPH were detected in most media and were retained as CPCs in the BERA, these analytes could not be evaluated directly in the BERA because there are no relevant toxicity data for ecological receptors. Instead, the individual VOCs and PAHs detected by Methods 8260 (LM 19) and 8270 (LM 18), for which there generally are toxicity data, were evaluated instead. VOCs and PAHs are generally considered to be the fractions most likely to adversely affect ecological receptors, and Methods 8260 and 8270 provide more accurate measurements of the levels of VOCs and PAHs that are often associated with fuel-related compounds.

9.2.3.1 Area 2 Upland Surface Soil. Summary statistics for five surface soil samples (57B-95-01X, 57B-95-02X, 57E-95-02X, 57E-95-10X, and 57E-95-25X) collected in the upland portion of Area 2 (shown in Figure 5-8) are presented in Table 9-47. All organic analytes including six VOCs (three chlorinated solvents and three aromatic hydrocarbons), seven SVOCs (including five PAHs), 4,4'-DDE, 4,4'-DDT, and TPHC were retained as CPCs in the BERA. Six of the 18 inorganic analytes detected in soil (arsenic, cobalt, copper, manganese, nickel, and selenium) were retained as CPCs because their maximum detected concentrations exceed background.

9.2.3.2 Area 2 Floodplain Surface Soil. Summary statistics for eleven surface soil samples (57E-95-12X, 57E-95-16X, 57E-95-17X, 57S-98-01X, 57S-98-02X, 57S-98-04X, 57S-98-06X, 57S-98-07X [0-1 and 1-2 ft. bgs], 57S-98-08X, and 57S-98-09X) (shown in Figure 5-8) collected in the floodplain portion of Area 2 are presented in Table 9-48. All organic analytes including seven VOCs (including four chlorinated solvents and two aromatic hydrocarbons), nine SVOCs (including eight PAHs), 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aroclor-1260, dieldrin, and TPHC were retained as CPCs in the BERA. Eight of the 19 inorganic analytes detected in soil (antimony, arsenic, barium, copper, lead, manganese, selenium, and zinc) were retained as CPCs because their maximum detected concentrations exceed background.

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G:\Projects\USAEC\PROJECTS\57RITEXT\final\57finaltext.doc June 6, 2000 **9.2.3.3** Area 3 Surface Soil. Summary statistics for twelve surface soil samples (57B-95-08X, 57B-95-09X, 57S-98-11X through 57S-98-16X [collected 0-1 ft. bgs], 57S-98-12X through 57S-98-14X [collected 1-2 ft. bgs], and EX57W15X) collected from Area 3 are presented in Table 9-49 (shown in Figure 5-9). All organic analytes including chlorobenzene, tetrachloroethylene, toluene, four PAHs, two dichlorobenzenes, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aroclor-1260, alpha-chlordane, gamma-chlordane, TPHC, and EPH/VPH were retained as CPCs in the BERA. Four of the eighteen inorganic analytes detected in soil (arsenic, cadmium, manganese, and selenium) were retained as CPCs because their maximum detected concentrations exceed background.

9.2.3.4 Area 2 Surface Water. Summary statistic for nine surface water samples (57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57W-98-01X through 57W-98-03X) collected from the emergent marshes in the vicinity of AOC 57 and in the scrub/shrub swamp and Cold Spring Brook channel downstream of AOC 57 (shown in Figure 5-6 and 5-8) are presented in Table 9-50. All organic analytes including five chlorinated solvents, carbon disulfide, toluene, phenanthrene, bis(2-ethylhexyl)phthalate, TPHC, and EPH were retained as CPCs in the BERA. All of the inorganic analytes (except for the essential nutrients) detected in filtered and unfiltered surface water samples were retained as CPCs because their maximum detected concentrations exceed upgradient concentrations. In addition, the water quality parameters alkalinity, chloride, and total suspended solids were retained for consideration in the BERA.

Seven of the unfiltered inorganic CPCs (aluminum, cadmium, chromium, copper, mercury, selenium, and vanadium) were not detected in filtered surface water, suggesting that these analytes may be sorbed to suspended solids within the water column and, therefore, may not be bioavailable. In addition, most of these analytes (cadmium, chromium, mercury, and vanadium) were only detected in sample 57D-95-04X located in the emergent marsh upgradient of the AOC 57 berm, where the total suspended solids were measured at 504,000 μ g/g. None of these analytes were detected at 57D-95-05X, which is located at the edge of the floodplain adjacent to the berm, where contaminants from AOC 57 Area 2 would expect to be the highest. Maximum concentrations of other inorganics in Area 2 surface water (aluminum, calcium, copper, iron, magnesium, potassium, sodium, vanadium, and zinc) were also detected at 57D-95-04X. Maximum concentrations of manganese, barium, arsenic, and lead were detected at 57W-98-02X, where the total suspended solids were measured at 10,500,000 μ g/g. It is believed that the elevated concentrations of these metals at 57W-98-02X, are artifacts of the total suspended solids.

9.2.3.5 Area 3 Surface Water. Summary statistic for five surface water samples (57W-98-04X through 57W-95-08X) collected in the floodplain swamp downgradient of Area 3 (shown in Figure 5-9) are presented in Table 9-51. All organic analytes including chlorobenzene, carbon disulfide, toluene, benzo(k)fluoranthene, and EPH/VPH were retained as CPCs in the BERA. With the exception of manganese, all of the inorganic analytes detected in filtered and unfiltered surface water samples were retained as CPCs because their maximum detected concentrations exceed upgradient concentrations. In addition, the total suspended solids measured in Area 3 surface water was considered in the BERA.

As with Area 2, several of the unfiltered inorganic CPCs (antimony, copper, lead, selenium, and zinc) were not detected in filtered surface water, suggesting that these analytes may not be bioavailable. The total suspended solids measured at Area 3 were very high (3,240,000 to 15,800,000 μ g/L) due to the sampling conditions (shallow areas of pooled water in groundwater seep locations). The elevated concentrations of nearly all unfiltered inorganics are believed to be an artifact of the high total suspended solids.

9.2.3.6 Area 2 Sediment. Summary statistics for nine sediment samples (57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57D-98-01X through 57D-98-03X) which are collocated with the Area 2 surface water samples (shown in Figures 5-6 and 5-8), are presented in Table 9-52. All organic analytes including four chlorinated VOCs, acetone, toluene, five PAHs, the DDT_R family (i.e., 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT), Aroclor-1260, dieldrin, TPHC, and diesel fuel were retained as CPCs in the BERA. All nineteen of the inorganic analytes (except for the essential nutrients, cadmium, and vanadium) detected in sediment were retained as CPCs because their maximum detected concentrations either exceed upgradient concentrations or are greater than "normal" concentrations for lakes and ponds as classified by Rojko (1990). TOC was measured at concentrations ranging from 84,900 to 602,000 μ g/g.

9.2.3.7 Area 3 Sediment. Summary statistics for five sediment samples (57D-98-04X through 57D-95-08X) which are collocated with the Area 3 surface water samples (shown in Figures 5-6 and 5-9), are presented in Table 9-53. All organic analytes including four aromatic VOCs, acetone, seven PAHs, two dichlorobenzenes, 4,4'-DDD, Aroclor-1260, TPHC, and EPH/VPH were retained as CPCs in the BERA. None of the inorganic analytes detected in sediment was retained as CPCs because their maximum detected concentrations either exceeded the upgradient concentration or the "normal" concentration for lakes and

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ponds as classified by Rojko (1990). TOC was measured at concentrations ranging from 38,400 to 210,000 μ g/g.

9.2.3.8 Area 2 Groundwater. Summary statistic for eight groundwater samples (57M-95-04A, 57M-95-04B, 57M-95-05X through 57M-95-07X, 57M-95-08A, 57M-95-08B, and 57P-98-02X) collected from the upland and floodplain portions of Area 2 (shown in Figures 5-6 and 5-8) are presented in Table 9-54. All organic analytes including three chlorinated solvents, toluene, acetone, two phthalates, and Endosulfan II were retained as CPCs. Six of the inorganic analytes detected in filtered and unfiltered groundwater samples were retained as CPCs because their maximum detected concentrations are greater than background concentrations.

9.2.3.9 Area 3 Groundwater. Summary statistics for seven groundwater samples (57M-95-03X, 57M-96-10X through 57M-96-13X, 57P-98-03X, and 57P-98-04X) collected from Area 3 (shown in Figure 5-9) are presented in Table 9-55. All organic analytes including six chlorinated solvents, five aromatic hydrocarbons, two dichlorobenzenes, two PAHs, bis(2-ethylhexyl)phthalate, and 4-methylphenol were retained as CPCs. Eight of the inorganic analytes detected in groundwater samples were retained as CPCs because their maximum detected concentrations exceed background concentrations. Two of the unfiltered inorganic CPCs (cadmium and copper) were not detected in filtered groundwater, suggesting that these analytes would not be released to surface water or be bioavailable.

9.2.4 Exposure Assessment

Exposure assessment is the process of estimating or measuring the amount of a CPC to which an ecological receptor may be exposed. The following sections briefly describe how contaminant exposures were estimated or measured for wildlife, terrestrial plants, soil invertebrates, and aquatic receptors at AOC 57. The contaminant pathway model (Figure 9-3) provides a summary of the potential exposure pathways that exist at AOC 57 for each group of receptors.

9.2.4.1 Calculation of EPCs. RME and average EPCs were chosen for all CPCs in surface soil, surface water, sediment, and groundwater to evaluate exposures to receptors. RME concentrations represent the highest concentration of an analyte that ecological receptors could potentially encounter at the site, whereas average EPCs represent typical site concentrations. For most of the data sets in this BERA, the RME concentration is equal to the maximum detected concentration because the 95th percent UCL is not calculated when

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G:\Projects\USAEC\PROJECTS\57RITEXT\final\57finaltext.doc June 6, 2000 there are fewer than 10 samples in the data set. For Area 2 floodplain surface soil, the RME concentration is equal to the lower of the maximum detected concentration or the 95th percent UCL. The average of all samples is used to represent the average EPC unless it exceeds the maximum EPC, in which case the maximum EPC is used for both scenarios. The average of all concentrations may exceed the maximum detected concentrations in situations where there were few detects because a value of one-half of the SQL is assigned to all samples in which the analyte is not detected; this may, in some cases, artificially elevate the average.

RME and average EPCs are presented in Tables 9-47 through 9-55 for surface soil, surface water, sediment, and groundwater. A tiered approach was used to efficiently evaluate exposure and risk at AOC 57; if no risk was calculated from exposure to the RME concentrations, then average exposure scenarios were not evaluated. Likewise, if there are no risks for unfiltered surface water, then risks were not estimated for filtered surface water because filtered surface water results, which represent the bioavailable form of an analyte in water, are generally lower.

9.2.4.2 Wildlife. Exposure routes for wildlife receptors include direct or indirect ingestion of AOC 57 soil, surface water, sediment, and ingestion of contaminated food. To evaluate exposures at AOC 57, representative wildlife species were selected for evaluation in food chain models that estimate contaminant exposures to wildlife species respective to their position in the food chain. Ecological exposures for the AOC 57 BERA are assumed to occur within the top two feet of soil, and the top 6 inches of sediment. Contaminant exposures for wildlife are related to the foraging characteristics of the species; therefore, terrestrial and semi-aquatic receptors were chosen to represent the trophic levels typically found in disturbed uplands, forested floodplain, scrub/shrub, and emergent marsh communities. The following representative wildlife species (summarized in Table 9-56) were selected for evaluating food-chain exposures in the AOC 57 BERA:

- White footed mouse (*Peromyscus leucopus*). The white-footed mouse represents a small granivorous mammal (i.e. feeding primarily on seeds and young grass shoots) that inhabits wooded or scrub/shrub habitats. Invertebrates also make up a small portion of this receptor's diet. The white-footed mouse represents granivorous mammals found in terrestrial areas at AOC 57.
- Short-tailed shrew (*Blarina brevicauda*). The short-tailed shrew finds suitable habitat in forests, fields, marshes, and brush. It primarily feeds on earthworms,

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snails, centipedes, insects, small vertebrates, and slugs (DeGraaf and Rudis, 1986). Relative to other small mammals, insectivorous species such as the shrew may receive high doses of contamination as a result of their voracious appetite relative to their small body size and the ability of their prey items to accumulate constituents. The shrew represents small mammalian omnivores found in the floodplain forest at AOC 57.

- **Muskrat** (*Ondatra zibethicus*). This herbivorous mammal is widespread throughout North America (Burt and Grossenheider, 1976). Its preferred habitat includes marshes, portions of lakes, ponds, swamps, sluggish streams, and drainage ditches; it is most abundant in regions with cattails (*Typha* sp.) (DeGraaf and Rudis, 1983). Muskrats feed on a variety of aquatic and emergent plant species, including cattails, common reed (*Phragmites australis*), bulrushes (*Scirpus* sp.), and a variety of grasses; this rodent will also occasionally feed on mollusks, crayfish, frogs, and fish (DeGraaf and Rudis, 1983; Baker, 1983; Burt and Grossenheider, 1976). The muskrat represents lower trophic level herbivorous mammals found in Cold Spring Brook at AOC 57.
- American robin (*Turdus migratorius*). The robin is often seen perched in open woodlands and foraging in developed areas such as maintained grassy lawns. The robin represents avian receptors that consume earthworms, insects, and plants, and was selected to represent avian omnivores in terrestrial areas at AOC 57.
- Mallard (*Anas platyrhynchos*). The mallard is a herbivorous bird (i.e. feeding primarily on submergent vegetation and seeds of herbaceous emergent vegetation) that inhabits wetlands. This widely distributed duck is found throughout temperate regions of the world and is the most abundant duck species throughout much of the northern hemisphere. The mallard represents herbivorous birds found in Cold Spring Brook at AOC 57.
- Red fox (*Vulpes vulpes*). This omnivorous mammal prefers open woodlands and grassy fields, and is most active at dawn, dusk, and night. It is an opportunistic forager, feeding on small mammals, birds, amphibians, reptiles, and invertebrates, as well as berries and other fruits (Burt and Grossenheider, 1976). The red fox represents predatory mammals in terrestrial portions of AOC 57.

- Raccoon (*Procyon lotor*). The raccoon represents an opportunistic species that is commonly found in virtually every aquatic habitat and developed areas. Although raccoons are primarily active from sunset to sunrise, raccoons will change their activity period to accommodate food and water (USEPA, 1993a). Raccoons will consume a variety of food items, but optimally feed on fleshy fruits, nuts, acorns, grains, insects, frogs, crayfish, and eggs (USEPA, 1993d). The raccoon represents higher trophic level omnivorous mammals found in the floodplain and Cold Spring Brook at AOC 57.
- **Barred owl** (*Strix varia*). The barred owl is primarily a nocturnal hunter. Its habitat includes low, wet woods and heavily wooded swamps. The barred owl prefers hunting for its primary prey items (consisting of small mammals, birds, and frogs [Audubon, 1994]) in open fields surrounded by woodland. The owl represents predatory avian receptors found in terrestrial portion of AOC 57.
- Great blue heron (*Ardea herodias*). This species represents a higher trophic level wading avian receptor that feeds primarily on aquatic life including fish, frogs, and invertebrates. Great blue herons inhabit freshwater and marine lakes, rivers, brackish marshes, and lagoons where small fish can be found in shallow water (USEPA, 1993a). The heron has been selected to represent wading-bird receptors potentially found in Cold Spring Brook at AOC 57.

Exposure assumptions (body weights, food ingestion rates, site foraging frequency [SFF], exposure duration [ED], relative consumption of food items, etc.) for each of the representative wildlife species for AOC 57 are provided in Appendix O-1, Table O-1.1.

The SFF considers the frequency a receptor feeds within the site area by estimating the acreage of the site relative to the receptor's home range. By definition, the SFF cannot exceed 1. All three surface soil areas (Area 2 uplands, Area 2 floodplain, and Area 3), calculated to be approximately 0.5, 0.3, and 0.2 acres (respectively) are larger than the home range for the white-footed mouse. In addition, the Area 2 uplands are larger than the home range for the robin, and the Area 2 surface water and sediment (calculated to be approximately 0.7 acres) is greater than the home range of the muskrat. Accordingly, it is assumed that the SFF for these receptors in these areas is 1 (i.e., these receptors forage exclusively within the site area). The available floodplain habitat for ecological receptors at Area 3 is somewhat limited in that the forested floodplain generally lacks standing water, except for a few small pools where seeps occur. The raccoon was, therefore, the only semi-

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aquatic wildlife receptor evaluated for exposures since suitable habitat does not exist for muskrats, mallards, or herons.

To estimate receptor exposures to contaminants in site media and contaminated food items, a Potential Dietary Exposure (PDE) (or body dose) is estimated for all representative wildlife species for each CPC in all media according to the equations in Table 9-50. Tissue concentrations of CPCs in prey items were either measured directly or estimated using bioaccumulation factors (BAFs) for surface soil and sediment and bioconcentration factors (BCFs) for surface water. The general approach for evaluating bioaccumulation exposures to wildlife at AOC 57 is summarized in Table 9-58. Literature-derived BAFs and BCFs are presented in Appendix O-1, Table O-1.2.

Bioaccumulation is defined as "a process by which chemicals are taken up by aquatic organisms from water directly or through consumption of food containing the chemicals" whereas bioconcentration is "the process by which there is a net accumulation of a chemical directly from water into aquatic organisms resulting from simultaneous uptake (e.g., by gill and epithelial tissue) and elimination" (Rand and Petrocelli, 1985).

Studies have indicated that the magnitude of fish tissue contaminant burden may not be directly related to the magnitude of sediment contamination (Weiner, 1993). It is likely that other factors, including fish lipid content, variations in exposure parameters, trophic level of the fish evaluated, and trophic status of the aquatic resource evaluated may explain ecological partitioning of analytes in aquatic systems (Rowen and Rasmussen, 1992). Therefore, average CPC concentrations detected in crayfish and small fish tissue were used directly in food web models for evaluating semi-aquatic wildlife exposures to CPCs detected in Cold Spring Brook surface water and sediment. Site-specific tissue data for crayfish and small fish are presented in Appendix O-1, Table O-1.3.

When tissue concentrations were not available, BAFs and BCFs that provide estimates of direct uptake from sediments and surface water (respectively) were used instead. BAFs and BCFs were extrapolated from literature values or estimated using regression equations. BCFs calculated from data derived from the AQUIRE database and from AWQC documents are presented in Appendix O-1, Table O-1.4. BAF values were converted to a wet weight tissue value. Based on the lack of scientific data for VOC bioaccumulation and evidence provided in several reference materials (Suter, 1993; Maughan, 1993), an assumption was made that VOCs do not bioaccumulate in prey tissue.

BAFs for terrestrial invertebrate and plant prey items are the ratio of the CPC concentration in plant or invertebrate tissue (mg contaminant/kg tissue wet weight) to the CPC concentration in soil (mg contaminant/kg dry weight). BAFs reported in the scientific literature for avian and mammalian receptors are the ratio of CPC concentrations in the tissues of these receptors (mg contaminant/kg tissue wet weight) to the concentrations of CPCs in their food items (mg contaminant/kg tissue wet weight).

Dietary exposures for semi-aquatic receptors were estimated by multiplying the sediment CPC concentration by the aquatic invertebrate BAFs, or by multiplying surface water CPC concentrations by BCFs (based primarily on fish uptake of contaminants by gill epithelial). If a given analyte was detected in both media, semi-aquatic prey concentrations were estimated as the higher of these two calculations.

The PDEs calculated from exposure to AOC 57 surface soil, surface water, and sediment CPCs for each receptor are presented in Appendix O-2, Tables O-2.1 through O-2.11.

9.2.4.3 Terrestrial Plants and Invertebrates. Terrestrial plants and soil invertebrates may be exposed to CPCs via direct contact with, root uptake (plants), or ingestion (invertebrates) of CPCs measured in AOC 57 surface soil. For the purposes of the AOC 57 BERA, exposures to terrestrial plants and invertebrates are assumed to occur within the top 2 feet of surface soil.

9.2.4.4 Aquatic Receptors. Aquatic organisms may be exposed to CPCs via direct contact with surface water and sediment. Benthic aquatic organisms in Cold Spring Brook may also be exposed to groundwater CPCs in the future as they discharge to the surface. Aquatic organism exposures to the full concentrations of analytes in groundwater are considered in the AOC 57 BERA; however, this exposure assumption may be overly conservative because concentrations of analytes may attenuate before reaching a discharge area.

As previously mentioned, a bioaccumulation study using the freshwater oligochaete (*Lumbriculus variegatus*) was performed in 1995 to evaluate the potential for Area 2 sediment-related contaminants to bioaccumulate in benthic invertebrate tissue. The results of this study are presented in Appendix Q. All test methods were performed in accordance with *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (USEPA, 1994). Three replicate oligochaete cultures maintained by the toxicity test laboratory were exposed to each of four Cold Spring Brook sediments (from sample locations 57D-95-05X, 57D-95-06X, 57D-95-08X)

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[reference location], and the laboratory control) for 28 days. Following the 28-day period, oligochaetes were purged of their stomach contents for 24 hours, frozen, and shipped to the analytical laboratory for chemical analysis. Due to problems encountered during shipping, the oligochaete samples arrived at the analytical laboratory 48 hours after shipment, rather than the 24 hours recommended in the test methods. Samples were received at the laboratory at 20° C. Oligochaete tissue was analyzed for PAL pesticides and PCBs; due to limited sample sizes (3 grams wet weight), the detection limits that were achievable by the analytical laboratory were slightly elevated.

Aquatic invertebrate BAFs were calculated for pesticides and PCBs using the paired oligochaete tissue and Cold Spring Brook Area 2 sediment concentrations (presented in Appendix O-1, Table O-1.3). However, due to uncertainties surrounding the oligochaete tissue results, these data were not used in the AOC 57 BERA to evaluate exposures to wildlife foraging for freshwater invertebrates in Cold Spring Brook. Specifically, several analytes were detected in Cold Spring Brook sediments but were not detected in oligochaete tissue; conversely, aldrin was detected in oligochaete tissue but was not detected in Cold Spring Brook Area 2 sediments. The concentrations of aldrin and the two other detected contaminants, tetra-chloro-m-xylene and decachlorobiphenyl, were actually highest in control oligochaete tissue. Based on inquiries made with the analytical laboratory, the analytes detected in oligochaete tissue may be attributable to laboratory contamination and/or unreliable quantitation limits.

In addition to the bioaccumulation study, subchronic toxicity tests were also performed in 1995 using the midge (Chironomus tentans) and the amphipod (Hyalella azteca). These benthic and epibenthic (respectively) invertebrates were exposed to sediment samples collected from 6 sample locations in Area 2 Cold Spring Brook (57D-95-04X through 57D-95-08X, and 57D-95-10X), shown in Figure 5-6 and 5-8. Sediment toxicity studies were conducted in accordance with the guidelines Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates (USEPA, 1994). Eight replicates of laboratory-raised midges and vendor-supplied amphipods were exposed to whole sediment in 10-day static renewal toxicity tests. The results of these tests were used to evaluate the potential toxicity to these receptors from exposure to sediment contamination. Results of the AOC 57 sediment toxicity testing are presented in Table 9-59, Appendix Q. Because no toxicity testing was performed in Area 3, the results from Area 2 are used to represent conditions for both areas. This is conservative as the aquatic habitat at Area 2 (Cold Spring Brook and associated marshes) supports more sensitive aquatic organisms than at Area 3 (forested floodplain with little standing water).

9.2.5 Ecological Effects Assessment

As stated in the problem formulation, the assessment endpoints of the BERA are the survival and propagation of ecological receptor populations at AOC 57. The ecological effects assessment discusses what measurement endpoints were used to represent the assessment endpoints evaluated in this BERA. Terrestrial and semi-aquatic wildlife receptors, terrestrial plants, terrestrial invertebrates, and aquatic organisms are potentially exposed to CPCs detected in AOC 57 site media; the measures of adverse ecological effects for these receptors are discussed separately.

9.2.5.1 Terrestrial and Semi-aquatic Wildlife. Because no long-term wildlife population data are available at Devens, a direct measurement of the survival and propagation of wildlife populations at AOC 57 is not possible. The literature-derived results of laboratory toxicity studies that relate the dose of a contaminant in an oral exposure with an adverse response to growth, reproduction, or survival of a test population (avian or mammalian species) were used in food-web models as a measure of the assessment endpoint. Lethal and sublethal wildlife ingestion toxicity data (which are used to derive reference toxicity values [RTVs] for evaluating risk) are presented in Appendix O-1, Table O-1.5. Wildlife effects from exposure to CPCs in Area 2 upland surface soil, Area 2 floodplain surface soil, Area 3 surface soil, and Cold Spring Brook surface water and sediment were evaluated in the AOC 57 BERA.

For each CPC identified and each representative wildlife species selected, two RTVs are identified. A lethal RTV represents the threshold for lethal effects and is based on oral LD_{50} data (oral dose [in mg/kg body weight-day] lethal to 50 percent of a test population). The lethal RTV is equal to one-fifth of the lowest reported LD_{50} for the most closely related test species; this is considered to be protective against lethal effects for 99.9 percent of individuals in a test population (USEPA, 1986). When LD_{50} data were not available, a LOAEL for lethal effects was selected. A sublethal RTV is selected to represent a threshold body weight-normalized dose for adverse effects related to reproduction or growth. A summary of RTVs selected from the ingestion toxicity data are provided in Appendix O-1, Table O-1.6

The RTV used for evaluating adverse effects to wildlife is conservatively selected as the lesser of the lethal or sublethal RTVs derived from the literature. If neither lethal nor sublethal toxicity information were available for a taxonomic group, RTVs from another

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9.2.5.2 Terrestrial Plants and Invertebrates. Site-specific toxicity data for terrestrial plants and invertebrates are not available for AOC 57. Therefore, the results of toxicity studies from the literature that relate the soil or groundwater concentrations of a contaminant with adverse growth, reproduction, or survival effects of a test population are used as a measure of the assessment endpoint. These study results are summarized in Appendix O-1, Tables O-1.7 (plants) and O-1.8 (invertebrates). Terrestrial plant and invertebrate effects from exposure to Area 2 upland surface soil, Area 2 floodplain surface soil, and Area 3 surface soil are evaluated in the AOC 57 BERA.

For plants, the effects primarily considered were measures of growth or yield as these response parameters are most common in phytotoxicity studies. For invertebrates, the effects primarily considered were measures of reproduction or mortality; when LC_{50} data were used, one-fifth of the LC_{50} was used to be protective of 99.9 percent of the population (USEPA, 1986).

9.2.5.3 Aquatic Receptors. Aquatic organism effects from exposure to surface water and sediment are evaluated in the AOC 57 BERA. Potential adverse ecological effects associated with CPCs in sediment were evaluated based on the results of the Area 2 sediment toxicity study using the midge and amphipod. A summary of the results of the sediment toxicity test for the amphipod and midge are presented in Table 9-59 and in Appendix Q. In addition, adverse effects to aquatic receptors from direct contact with CPCs in Area 2 and 3 surface water and sediment were evaluated by comparing the CPC concentrations with literature-derived benchmarks.

Midge growth was significantly lower in sediment sample 57D-95-04X (1.36 \pm 0.30 grams) than was observed in the upstream reference sample (57D-95-08X) (1.81 \pm 0.30 grams); however, midge growth in 57D-95-04X was not significantly lower than in the control sample (1.70 \pm 0.32 grams). Midge survival results showed no statistical differences from the control or reference samples.

Survival and growth results for amphipods reared in Area 2 Cold Spring Brook sediment samples showed no statistically significant differences from the control or reference samples. However, there is uncertainty associated with the amphipod control results because the control sample did not meet the 80 percent acceptance criteria for survival.

Based on inquiries with the toxicity test laboratory, these results may be attributable to several factors: the vendor-supplied amphipod stock may have been stressed from shipment to the toxicity test laboratory and, therefore, more susceptible to other stressors; or the control sediment used for this study (which was collected at Strobs Folly Brook in Wareham, Massachusetts) may have been contaminated. Regardless, amphipod survival in the Cold Spring Brook sediment samples ranged from 70 to 84 percent; these results are not statistically significantly different from the results observed in the reference sample collected upstream of AOC 57, which achieved an average 80 percent survival rate.

In addition to the sediment toxicity test results, literature values that relate the concentration of a contaminant with an effect level (derived from data for adverse growth, reproduction, or survival effects of test populations) are used as a measure of the assessment endpoint.

Surface water RTVs selected for comparison to surface water exposure concentrations include Federal chronic AWQC (USEPA, 1991b; USEPA, 1988a) and aquatic toxicity information from the USEPA AQUIRE database (AQUIRE, 1996). Effects concentration data obtained from AQUIRE are included in Appendix O-1, Table O-1.8. Chronic AWQC are concentrations that, if not exceeded by the four-day average chemical concentration more than once every three years, are protective of most species of aquatic life and its uses (USEPA, 1983). Lowest observed effects concentrations measuring survival, growth, reproduction, and biodiversity endpoints were derived from the AQUIRE database as a supplement to the AWQC (AQUIRE, 1996).

Sediment benchmarks selected for comparison to detected sediment concentrations include the following: National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) sediment guidelines (Long et al., 1995) based on the National Status and Trends Program approach; USEPA Sediment Quality Guidelines (SQG) based on equilibrium partitioning (USEPA, 1988b; USEPA, 1993b,c,d); Ontario Ministry of the Environment (OME) Lowest Effect Level (LEL) provincial sediment quality guidelines (Persaud et al., 1996) based on the Apparent Effects Threshold (AET) approach; and New York State Department of Environmental Conservation sediment quality criteria (NYSDEC, 1994).

The sediment benchmarks selected for evaluating risk to benchic organisms represent chemical concentrations below which biological effects are improbable (by the Apparent Effects Threshold method [USEPA, 1992b]), or that may rarely (i.e., 10th percentile) or sometimes (i.e., 50th percentile) be associated with toxicity to benchic organisms (by the

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National Status and Trends Program Approach [USEPA, 1992b]). A third sediment benchmark uses bulk sediment concentrations and the organic carbon content in sediment to predict interstitial water concentrations that are equal to the chronic AWQC. Since the AWQC are protective of 95 percent of aquatic species, these bulk sediment concentrations (generated using the Equilibrium Partitioning Approach) are expected to be equally conservative in evaluating adverse effects to benthic organisms (USEPA, 1992b).

9.2.6 Risk Characterization

This subsection discusses how risks are characterized for ecological receptors exposed to contaminated media at AOC 57. A comparison of exposure information with the appropriate concentration-response toxicity data is the basis for risk characterization. In addition, a qualitative comparison between groundwater CPCs and concentrations of chemicals detected in Cold Spring Brook was performed to evaluate potential future impacts to the stream and other downgradient waterbodies.

9.2.6.1 Terrestrial and Semi-aquatic Wildlife. Risks for the representative wildlife species associated with ingestion and bioaccumulation of CPCs in surface soil and prey items are quantitatively evaluated using HQs, which are calculated for each CPC by dividing the PDE based on RME concentrations by the selected lethal or sublethal RTV. HIs are determined for each receptor by summing the HQs for all CPCs. When the estimated PDE is less than the RTV (i.e., the HQ < 1), it is assumed that chemical exposures are not associated with adverse effects on survival, growth, or reproduction for receptors and no risks to wildlife populations exist. When an HI is greater than 1, a discussion of the ecological significance of the HQs of contaminants with mechanistically distinct modes of action, and possibly distinct target organs of toxicity. Summation of such HQs therefore provides an overly conservative estimate of the contaminant stressor on the receptor.

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, lethal or sublethal 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.

The HQs and HIs calculated based on RME and average EPCs for each representative wildlife species are provided in Appendix O-2, Tables O-2.12 through O-2.22. A summary of risks to representative wildlife receptors is provided in Table 9-60, and in the following paragraphs. There are no toxicity data available relating wildlife exposures to TPHC with adverse responses; therefore, TPHC exposures were not included in the food-web model, and potential adverse effects from TPHC exposure remain an uncertainty.

<u>Area 2 Upland Surface Soil</u>. The HQs and HIs calculated for each representative wildlife species are provided in Appendix O-2, Tables O-2.12 and O-2.13; a summary of risks is provided in Table 9-60. The summary HI for the white-footed mouse exposed to RME concentrations in Area 2 upland soil is 1.5. The primary risk contributor to the mouse is arsenic, which was detected at a maximum concentration (21 μ g/g) that only slightly exceeds the background concentration for arsenic (19 μ g/g). The summary HI for the mouse based on average EPCs in Area 2 upland soil (which are more representative of site conditions) is 0.98. Summary HIs for all other wildlife receptors exposed to RME and average EPCs in Area 2 upland soil are less than 1. These results suggest that adverse effects to wildlife receptors from exposure to Area 2 upland surface soil are not likely to occur. Furthermore, the selected RTV for arsenic may be overly conservative as the HI estimated at background concentrations would also exceed 1.

<u>Area 2 Floodplain Surface Soil</u>. The HQs and HIs calculated for each representative wildlife species are provided in Appendix O-2, Tables O-2.14 and O-2.15; a summary of risks is provided in Table 9-60. The summary HI for the white-footed mouse, short-tailed shrew, and American robin exposed to RME concentrations in Area 2 floodplain soil are 4.0, 2.4, and 1.8, respectively. Arsenic, with an RME concentration of 47.9 μ g/g, contributes to 76 and 49 percent of the overall risk to the mouse and robin. Aroclor-1260 is a secondary risk contributor for the robin. Arsenic, selenium, and lead are primary risk contributors for the shrew, accounting for 21, 28, and 39 percent of the overall risk. The individual HQs for all analytes are less than 1 for the robin and shrew, suggesting that adverse effects from each analyte are minimal. The summary HIs for the mouse, shrew, and robin based on average EPCs in Area 2 floodplain soil (which are more representative of typical site conditions) are 1.9, 1.0, and 0.71, suggesting that risks to these receptors under

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typical exposures are minimal. Summary HIs for other wildlife receptors exposed to RME and average EPCs in Area 2 floodplain soil are less than 1.

<u>Area 3 Surface Soil</u>. The HQs and HIs calculated for each representative wildlife species are provided in Appendix O-2, Tables O-2.16 and O-2.17; a summary of risks is provided in Table 9-60. The summary HI for the white-footed mouse exposed to RME concentrations in Area 3 soil is 3.0. Arsenic, with an RME concentration of 41 μ g/g, contributes to 83 percent of the overall risk to the mouse. The summary HI for the mouse based on average EPCs in Area 3 soil (which are more representative of typical site conditions) is 1.7, suggesting that risk to the mouse under typical exposures is minimal. Summary HIs for other wildlife receptors exposed to RME and average EPCs in Area 3 soil are less than 1.

<u>Area 2 Surface Water and Sediment</u>. HQs and HIs were calculated for each representative wildlife species using both filtered and unfiltered surface water and sediment data. Risk calculations are provided in Appendix O-2, Tables O-2.18 through O-2.21, and a summary of risks is provided in Table 9-60. The RME and average summary HIs for the muskrat and great blue heron exposed to Area 2 Cold Spring Brook unfiltered surface water and sediment exceed 1. Arsenic, lead, and manganese are the primary contributors to HIs of 13 (RME) and 4.6 (average) for the muskrat. Mercury is the primary risk contributors for the heron, with HIs of 12 (RME) and 6.8 (average), respectively.

As mentioned in subsection 9.2.3.4, concentrations of metals in unfiltered surface water were all elevated at sample locations 57D-95-04X and 57W-98-02X, which is probably related to the total suspended solids measured in those samples (504,000 and 10,500,000 μ g/L). Using unfiltered samples may over-estimate the bioavailable fraction of metals in surface water. To reduce this potential bias, risks were re-evaluated by using filtered surface water data. All four metals were detected at very low concentrations (i.e., close to or below the AWQC) or not at all (e.g., mercury) in unfiltered surface water. The estimated risks using filtered surface water data were virtually the same for the muskrat (the RME HI = 13, and the average HI = 4.5), and were greatly reduced for the heron (the RME HI = 6.1, and the average HI = 1.8). These results suggest that arsenic, lead, and manganese in sediment may cause risk to herbivorous mammals, and mercury in sediment may cause risk to wading piscivorous birds. The bioconcentration potential of unfiltered mercury in surface water had a dramatic effect on risk estimates for the heron; however, mercury was not detected in the unfiltered sample, suggesting limited or no bioavailability.

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All four metals (arsenic, lead, manganese, and mercury) were detected at maximum concentrations in Area 2 sediment that are only two (or less) times higher than upgradient concentrations of these metals.

Arsenic and lead risk estimates for the muskrat are based on reproductive endpoints for rats, and the manganese risk estimate is based on an endpoint for survival. Therefore, it is possible that small herbivorous mammals may potentially experience adverse effects on reproduction or survival. However, the arsenic RTV (0.58 mg/kgBW/day) may be overly conservative for estimating risks for wildlife receptors. As discussed for Area 2 Upland surface soil, risks to wildlife receptors at background levels of arsenic in soil exceed 1. A three-generation study measuring the reproductive effects that arsenic had on rats resulted in a NOAEL of 1 mg/kgBW/day (ATSDR, 1999); if risks to wildlife receptors were calculated using this NOAEL as the arsenic RTV, arsenic risk estimates would be nearly one-half current estimates. In this example, the muskrat HI would drop to 9.4, with the arsenic HQ equal to 5.0. A search for more arsenic toxicity data may reveal higher effect doses. Given how conservative the selected arsenic RTV is, and the relatively low levels of risk contributed by lead and manganese (approximately 12 percent and 9 percent [respectively] of the overall risk, with maximum HQs of 1.7 and 1.3 [respectively]), adverse effects on small mammals from exposure to these analytes are unlikely.

The mercury risk estimate for the heron is based on a three generation reproductive behavior study on mallards; therefore, it is possible that wading piscivorous birds may experience adverse reproductive effects from exposure to RME concentrations of mercury in Area 2 Cold Spring Brook sediment. However, mercury was detected in only one sediment sample (57D-95-06X) at a concentration of $0.36 \ \mu g/g$. This concentration only slightly exceeds the range of "normal" sediment concentrations ($0.35 \ \mu g/g$) as defined by Rojko (1990). 57D-95-06X is located in the stream channel across from the berm, where site-related concentrations are *not* expected to be highest due to distance from the site and the low depositional nature of that area. It is more likely that mercury concentrations at 57D-95-06X are consistent with regional levels associated with atmospheric deposition, rather than site-related releases. Furthermore, the selected RTV is based on a study for methyl mercury, which may be overly conservative for estimating risks to wildlife receptors. There is no association of methyl mercury with AOC 57.

<u>Area 3 Surface Water and Sediment</u>. HQs and HIs were calculated for the raccoon using unfiltered surface water and sediment data from Area 3. Risk calculations are provided in Appendix O-2, Table O-2.22 and a summary of risks is provided in Table 9-60. The RME

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summary HI for the raccoon exposed to Area 3 floodplain unfiltered surface water and sediment is less than 1, suggesting that risks to omnivorous semi-aquatic mammals are unlikely. Given that no risks were estimated, risks to the raccoon were not estimated for filtered surface water or average exposure concentrations.

9.2.6.2 Terrestrial Plants. Risks for terrestrial plants were evaluated by comparing the selected phytotoxicity benchmarks (Appendix O-1, Table O-1.7) to RME and average EPCs. The results of the surface soil evaluations for AOC 57 are presented in Tables 9-61 through 9-63, and are discussed in the following paragraphs. There are no toxicity data available relating plant exposures to trichlorofluoromethane or TPHC with adverse responses; therefore, plant exposures to these analytes were not evaluated and potential adverse effects remain an uncertainty.

<u>Area 2 Upland Surface Soil</u>. RME and average EPCs of arsenic and the RME concentration for nickel in Area 2 upland surface soil exceed phytotoxicity benchmarks (Table 9-61). All other CPC exposure concentrations are less than phytotoxicity benchmarks, suggesting that plants are not at risk from exposure to VOCs, SVOCs, pesticides, cobalt, copper, manganese, or selenium in Area 2 upland surface soil.

As discussed in Subsection 9.2.6.1, the RME concentration for arsenic is consistent with background values for arsenic at Devens, and the average concentration is less than background. Therefore, the phytotoxicity benchmark for arsenic most likely over-estimates risk to plants. The RME concentration for nickel (30.7 μ g/g) only slightly exceeds its benchmark value (30 μ g/g), and only exceeds background values observed at Devens by a factor of 2. Furthermore, given the disturbed nature (i.e., off-road vehicular traffic) of the upland portion of Area 2, it is unlikely that arsenic and nickel concentrations in Area 2 upland surface soil would cause phytotoxic effects in plants; rather, other disturbances are more likely to act as stressors on plant growth and survival.

<u>Area 2 Floodplain Surface Soil</u>. RME and average EPCs of arsenic, lead, selenium, and zinc in Area 2 floodplain surface soil exceed phytotoxicity benchmarks (Table 9-62). All other CPC exposure concentrations are less than phytotoxicity benchmarks, suggesting that plants are not at risk from exposure to VOCs, SVOCs, pesticides, Aroclor-1260, antimony, barium, copper, or manganese in Area 2 floodplain surface soil.

Lead was detected in all eleven floodplain soil samples at concentrations ranging from 18.7 $\mu g/g$ to 320 $\mu g/g$. The RME (320 $\mu g/g$) and average (143 $\mu g/g$) concentrations of lead

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exceed the phytotoxicity benchmark by factors of approximately 5 and 3. Elevated concentrations of lead (i.e., >100 μ g/g) were observed in surface soil in two distinct areas at Area 2, located southeast and southwest of the erosion mat (including sample locations 57E-95-12X, 57E-95-15X, 57E-95-17X, 57S-98-02X, and 57S-98-07X through 57S-98-10X. It is possible that plants in these areas may exhibit phytotoxic effects from exposure to lead.

The RME (47.9 μ g/g) and average (24.1 μ g/g) concentrations of arsenic exceed the phytotoxicity benchmark for arsenic (10 μ g/g) by factors of approximately 5 and 2.4, respectively. However, this benchmark is less than the observed background concentration of arsenic in soil at Devens (19 μ g/g). It is possible that this phytotoxicity benchmark may overestimate risk to terrestrial plants.

The RME and average concentrations of selenium and zinc in Area 2 floodplain soil only slightly exceed their phytotoxicity benchmarks (all by less than 4.5). These slight exceedances suggest that potential risks to terrestrial plants from exposure to selenium and zinc are likely to be minimal.

It should be noted that all surface soil samples evaluated in the AOC 57 BERA were collected in areas characterized by dense floodplain forest growth; no signs of phytotoxicity have been observed at the site.

<u>Area 3 Surface Soil</u>. RME and average EPCs of arsenic, manganese (RME only), and selenium (RME only) in Area 3 surface soil exceed phytotoxicity benchmarks (Table 9-63). All other CPC exposure concentrations are less than phytotoxicity benchmarks, suggesting that plants are not at risk from exposure to VOCs, SVOCs, pesticides, PCBs, and cadmium in Area 3 surface soil.

RME concentrations of arsenic (41 μ g/g) and manganese (548 μ g/g) (both detected at 57B-98-08X) only exceed background values by a factor of 2 or less; the concentrations of these analytes detected at the other sample locations are less than background and the phytotoxicity benchmarks values. In addition, the maximum manganese and selenium concentrations only slightly exceeds their phytotoxicity benchmarks (500 and 1 μ g/g, respectively), and as previously stated, the arsenic phytotoxicity benchmark may overestimate risk as it is less than the background value for arsenic in Devens surface soil. This evidence suggests these analytes are not likely to cause phytotoxic effects for plants exposed to Area 3 surface soil.

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9.2.6.3 Terrestrial Invertebrates. Risks for terrestrial invertebrates were evaluated by comparing the selected invertebrate benchmarks (Appendix O-1, Table O-1.8) to RME and average EPCs. The results of the surface soil evaluations for AOC 57 are presented in Tables 9-61 through 9-63, and are discussed in the following paragraphs. There are no toxicity data available relating invertebrate exposures to antimony, barium, cobalt, manganese, selenium, PCBs, dibenzofuran, trichlorofluoromethane, or TPHC with adverse responses; therefore, invertebrate exposures to these analytes were not evaluated and potential adverse effects remain an uncertainty.

<u>Area 2 Upland Surface Soil</u>. RME and average EPCs for all analytes detected in Area 2 upland surface soil are less than soil invertebrate benchmarks, suggesting that invertebrates are not at risk from exposure to analytes in Area 2 upland soil (Table 9-61).

<u>Area 2 Floodplain Surface Soil</u>. The RME concentrations of copper (39.3 μ g/g) and zinc (150 μ g/g) slightly exceed the soil invertebrate benchmarks (30 and 130 μ g/g, respectively) (Table 9-62); however, these slight exceedances are not indicative of substantial risks to these receptors. All other RME and average EPCs are less than soil invertebrate benchmarks, suggesting that invertebrates are not at risk from exposure to Area 2 floodplain soil.

<u>Area 3 Surface Soil</u>. All RME and average exposure concentrations are less than invertebrate benchmark values (Table 9-63), suggesting that invertebrates are not at risk from exposure to analytes detected in Area 3 surface soil.

9.2.6.4 Aquatic Organisms. Risks for aquatic receptors from exposure to Area 2 and 3 surface water and sediment were characterized based on the toxicity test evaluation performed for the midge and amphipod, and a comparison of surface water and sediment EPCs with the toxicity benchmarks discussed in Subsection 9.2.5.

<u>Area 2 Surface Water - Benchmark Comparison</u>. The comparison of Area 2 filtered and unfiltered surface water EPCs with toxicity benchmarks is provided in Table 9-64. This comparison indicates that surface water concentrations of bis(2-ethylhexyl)phthalate and most metals exceed aquatic benchmark values. As discussed in Subsections 9.2.3.4 and 9.2.6.1, concentrations of metals in unfiltered surface water were elevated at sample locations 57D-95-04X and 57W-98-02X, which may possibly be related to the total suspended solids measured at those locations (504,000 and 10,500,000 μ g/L). These

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analytes were either not detected in any other surface water sample, or were detected at concentrations that are consistent with benchmark values.

Using unfiltered samples may over-estimate the bioavailable fraction of metals in surface water. Several metals that were only detected in unfiltered surface water (including cadmium, chromium, copper, mercury, selenium, and vanadium) were not detected in filtered samples, suggesting that these analytes are not bioavailable to aquatic organisms. Of the metals detected in filtered surface water, only iron, manganese, and zinc exceeded benchmarks. The RME and average EPCs for filtered manganese and zinc only slightly exceed their benchmark values. It is unlikely that exposure to these analytes would result in adverse effects.

Bis(2-ethylhexyl)phthalate was detected in only one of nine surface water samples, also at 57D-95-04X. This single detect exceeds the lowest adverse effect concentration in the AQUIRE database ($0.89 \ \mu g/L$ for moorfrog hatchability) by slightly less than two orders of magnitude. The maximum concentration does not exceed the proposed federal AWQC of 160 $\mu g/L$. A review of the AQUIRE database for bis(2-ethylhexyl)phthalate (Appendix O-1, Table O-1.9) indicates that the maximum concentration exceeds adverse growth, reproduction, or survival effects concentrations for the water flea, rainbow trout, and brook trout. Trout, which are coldwater species of fish, do not inhabit the surface waters at AOC 57. It is possible that some species of freshwater invertebrates and amphibians may be at risk from exposure to bis(2-ethylhexyl)phthalate detected at 57D-95-04X. However, given that bis(2-ethylhexyl)phthalate was only detected once in a relatively dynamic medium (i.e., these results may not be reproducible), and that it is not related to past site disposal activities, it is unlikely that unacceptable risks to water column populations are present.

Iron was detected in all surface water samples at concentrations ranging from 194 to 17,200 μ g/L in filtered samples, and from 592 to 17,600 μ g/L in unfiltered samples. The RME and average exposure concentrations exceed both the AWQC (1,000 μ g/L) and the lowest adverse effect concentration in the AQUIRE database (3,700 μ g/L for duckweed growth). The maximum iron concentration detected in unfiltered surface water was detected at 57D-95-04X, which, for the reasons previously mentioned, may not truly represent actual exposures to aquatic organisms. The maximum concentration of iron detected in filtered surface water at this location is stagnant and is in closest proximity to where contamination from AOC 57 may enter Cold Spring Brook. In addition, an organic sheen has been

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observed at this location in the past, suggesting that microbial activity at this location may be elevated. Concentrations of iron at all other Cold Spring Brook surface water samples are consistent with the benchmark values, indicating that adverse effects to aquatic organisms are unlikely to occur in other portions of the brook.

Based on the results of the surface water analysis, it is possible that concentrations of iron at 57D-95-05X may cause adverse effects to some aquatic organisms. Potential risks to aquatic organisms from exposure to bis(2-ethylhexyl)phthalate at 57D-95-04X, and filtered zinc and manganese at 57D-95-04X were also identified. The highest unfiltered metals concentrations and TPHC concentrations (924 μ g/L) in surface water were detected at 57D-94-04X, suggesting that the emergent marsh may be acting as a sink for metals and petroleum-related compounds that migrate from upgradient sources.

<u>Area 3 Surface Water - Benchmark Comparison</u>. The comparison of Area 3 filtered and unfiltered surface water EPCs with toxicity benchmarks is provided in Table 9-65. This comparison indicates that unfiltered surface water concentrations of copper, lead, and zinc exceed aquatic benchmark values. As discussed in Subsections 9.2.3.5 and 9.2.6.1, concentrations of metals in unfiltered surface water were elevated at sample locations, possibly related to the total suspended solids measured in Area 3 surface water (3,240,000 to 15,800,000 μ g/L). These analytes were not detected in unfiltered surface water sample, suggesting that they are not bioavailable to aquatic organisms. Therefore, exposures to these analytes are not likely to result in adverse effects.

<u>Sediment - Toxicity Test Results</u>. Risks for aquatic macroinvertebrates in AOC 57 sediment are characterized based on the results of sediment toxicity tests from samples collected in Cold Spring Brook. The sediment analytical and toxicity test samples were collected concurrently; therefore, the analytical results for the sediment samples can be used to help interpret the contaminant exposures and responses of the test species (midges and amphipods) in the toxicity tests. The results from these tests are used to interpret potential risks to aquatic organisms in both Areas 2 and 3 sediment.

As previously discussed in Subsection 9.2.5.3, midge growth was significantly lower in sediment sample 57D-95-04X than in the reference sample (57D-95-08X). No other statistically significant differences in midge or amphipod survival and growth were observed between the reference or control sediment samples and sediment collected from Cold Spring Brook. The maximum concentrations of copper (201 μ g/g), lead (410 μ g/g), and TPHC-diesel fraction (150 μ g/g) were detected in 57D-95-04X; concentrations of all

other metals, pesticides, PCBs, and SVOCs were negligible at this sample location.

Appendix O-3, Tables O-3.1 through O-3.3 present a series of simple linear regression analyses evaluating statistical relationships between biological effects observed in the midge toxicity test and concentration of copper, lead, and TPHC (diesel fraction) detected in AOC 57 sediment. Other sediment CPCs were not included in the regression analyses because there was no apparent relationship between concentrations and adverse biological response.

The results of the regressions indicate that midge growth is somewhat correlated with concentrations of copper and lead in sediment, but poorly correlated with concentrations of TPHC in AOC 57 sediment. The square of the correlation coefficient (r^2) values for copper, lead, and TPHC were 0.59, 0.67, and 0.078 (respectively). These results indicate that there may be a correlation between toxicity testing results and lead and copper concentrations in sediment. This evaluation does not consider the effects on the midge from a combined group of analytes.

<u>Area 2 Sediment - Benchmark Comparison</u>. The comparison of Area 2 sediment concentrations with benchmarks is provided in Table 9-66. This comparison indicates that sediment concentrations of most metals, pesticides, Aroclor-1260, PAHs, and acetone exceed aquatic benchmark values.

Maximum concentrations of metals do not appear to be spatially related (i.e., there is no pattern to where maximum concentrations are distributed), and concentrations generally exceed benchmark values at several sample locations. Metals concentrations generally exceed the NOAA ER-L's (which correspond to the 10th percentile of effects concentrations for aquatic organisms) and the OME LELs (which are designed to be protective of the majority of aquatic organisms). Maximum concentrations of PAHs (except chrysene) are co-located at 57D-95-07X, and maximum concentrations of DDT_R compounds are co-located at 57D-95-06X; however, as with metals, these analytes were detected at several sample locations that exceed sediment benchmarks. As with metals, concentrations of organic analytes generally tend to exceed the NOAA ER-Ls and the OME LELs.

Based on the toxicity test results for *C. tentans* and *H. azteca* (and the fact that copper and lead are not CPCs in Area 3 sediment), it is likely that this benchmark comparison method of evaluation may have over-estimated risk to aquatic organisms. Furthermore, the benchmark comparison with the bulk sediment inorganics concentrations may not be a good

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predictors of toxicity to aquatic organisms because of the affinity for certain metals to bind to sulfides. Elevated TOC levels in sediment may further limit metals bioavailability similar to organics, as seen by the fact that concentrations of organics are consistent with or less than the USEPA sediment quality guidelines that are adjusted to account for the TOC of sediment (e.g., most pesticides, Aroclor-1260, and the PAHs).

<u>Area 3 Sediment - Benchmark Comparison</u>. The comparison of Area 3 sediment concentrations with benchmarks is provided in Table 9-67. This comparison indicates that sediment concentrations of 4,4'-DDD, Aroclor-1260, PAHs, dichlorobenzenes, and acetone exceed aquatic benchmark values. Concentrations of chemicals detected in Area 3 sediment are generally an order of magnitude lower than those detected in Area 2 sediment.

Maximum concentrations of metals do not appear to be spatially related (i.e., there is no pattern to where maximum concentrations are distributed), and concentrations generally exceed benchmark values at several sample locations. Several of the maximum PAH concentrations are collocated at 57D-98-07X, and maximum concentrations of dichlorobenzenes, Aroclor-1260, and 4,4'-DDD are generally found at 57D-98-05X and 57D-98-06X. Concentrations of organic analytes generally tend to exceed the NOAA ER-Ls and the OME LELs, which are not corrected for the TOC content of sediment. Those USEPA toxicity benchmarks that are corrected for TOC are generally higher than RME concentrations of these analytes (except the RME concentration of 4,4'-DDD, which is less than two times higher than the TOC-adjusted guideline).

Given the generally lower concentration of chemicals in Area 3 sediment (as compared to Area 2), and based on the toxicity test results for *C. tentans* or for *H. azteca*, it is likely that this benchmark comparison method of evaluation may have over-estimated risk to aquatic organisms.

<u>Groundwater Concentrations</u>. Potential impacts to Cold Spring Brook surface water from groundwater discharge are evaluated by qualitatively comparing groundwater exposure concentrations to surface water exposure concentrations. The concentrations for these media are presented in Tables 9-50 (Area 2 surface water), 9-51 (Area 3 surface water), 9-54 (Area 2 groundwater), and 9-55 (Area 3 groundwater).

The results of this evaluation indicate that Area 2 groundwater may be influencing Area 2 surface water in Cold Spring Brook. Most of the same chlorinated solvents and metals were detected in these media; however, more metals were detected in surface water. Nearly all of

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the concentrations of analytes detected in unfiltered groundwater are less than in unfiltered surface water, but the opposite is true for filtered groundwater and surface water. Concentrations of tetrachloroethylene and bis(2-ethylhexyl)phthalate are also greater in groundwater than in surface water. While the chemicals detected in Area 2 surface water reflect many of those detected in groundwater, they do not seem to be a risk to aquatic organisms.

The chemicals detected in Area 3 groundwater differ substantially from those detected in surface water. Many chlorinated solvents (including carbon tetrachloride, chloroform, methylene chloride, tetrachloroethylene, and trichloroethylene) were detected in groundwater, but were not detected in surface water. In addition, Area 3 groundwater contains many fuel-related VOCs and other SVOCs or PAHs (including ethylbenzene, styrene, xylenes, 2-methylnaphthalene, naphthalene, 1,2- and 1,4-dichlorobenzene, bis[2-ethylhexyl]phthalate, and 4-methylphenol) that were not detected in surface water. Several metals (including barium, copper, lead, and zinc) were detected at higher concentrations in unfiltered Area 3 surface water than in unfiltered Area 3 groundwater. Surface water concentrations in the Area 3 floodplain are likely an expression of groundwater, but do not seem to reflect impacts from Area 3 groundwater.

9.2.7 Uncertainty Analysis

The objective of the uncertainty analysis is to discuss the assumptions of the BERA process that may influence the risk assessment results and conclusions. General uncertainties inherent in the risk assessment process and in the AOC 57 BERA are included in Table 9-68.

Additional uncertainties associated with the risk assessment at AOC 57 include the following.

• There is uncertainty associated with potential risks to rare, threatened, or endangered species. Although none of the species listed in Subsection 9.2.1.3 are confirmed residents at AOC 57, the MNHP identified several rare, threatened, or endangered species as occurring within one mile of AOC 57. Although risks for these specific receptors cannot be quantified, the following risk extrapolations can be made based on risk estimates for other receptors:

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- 1. based on risk estimates for plants, the ovate spike-sedge (endangered) may be at risk if exposed to lead in floodplain surface soil;
- based on risk estimates for plants, the Houghton's flatsedge (endangered), New England blazing star (special concern), and wild senna (endangered) may be at risk if exposed to lead in Area 3 upland soils at location (57B-95-09X);
- 3. based on risk estimates for the short-tailed shrew (an omnivorous mammal, whose diet of worms, slugs, and some plants most closely resembles that of turtles), the Blanding's turtle (threatened), eastern box turtle (special concern), and wood turtle (special concern) may be at risk if exposed to selenium and lead in floodplain surface soil;
- As noted in the BERA, there were no signs of stressed vegetation at AOC 57. Furthermore, risk extrapolations for threatened and endangered species may be overly conservative as these species may not reside at AOC 57. Additional uncertainties associated with the potential dietary exposures and risks to the reptiles listed in Subsection 9.2.1.3 are discussed in Table 9-68.
- There is uncertainty associated with the food chain risk evaluations for wildlife, . specifically associated with the selection of RTVs. Current Army guidance for conducting BERAs (Wentsel et al., 1997) suggests using NOAEL data for evaluating risks to wildlife. When NOAELs are not available, the guidance suggests applying uncertainty factors (UFs) of 10 to LOAELs, and 100 to LD₅₀s. In addition, the guidance also suggests applying other UFs to RTVs for inter-species extrapolations, and for laboratory-to-field extrapolations (effectively resulting in UFs of approximately 10,000 or more). These UFs are intended to add a degree of conservatism when evaluating risks for wildlife receptors for which specific toxicity data are lacking. While these UFs may be appropriate for use in screening-level assessments, they may add considerable uncertainty to BERAs, potentially compromising the credibility of the risk conclusions and resulting in spurious remedial actions. When UFs are applied to RTVs, risk estimates for wildlife receptors may indicate a much higher potential for risk than is realistically possible. For example, UFs applied to the arsenic RTV for reproductive effects in rats would result in a sublethal HQ of 101 for the white-footed mouse, indicating a high probability of risk at background concentrations of arsenic in soil (such as was detected in Area 2 upland soil). Multiple conservative assumptions for each analyte would result in cumulative risk estimates (i.e., an HI) in the thousands. For these

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reasons, the Army has decided not to apply UFs to RTVs in the AOC 57 BERA; therefore, the food chain evaluation may underestimate potential risks to wildlife receptors, according to the suggested guidance.

There is uncertainty associated with potential risks to ecological receptors from exposure to chemicals that had been eliminated from the ERA based on a comparison with background concentrations for surface soil, and upgradient concentrations and/or published values for Massachusetts lakes and ponds for surface water and sediment. Consequently, these potential risks have been quantified as part of the uncertainty analysis. Given that these chemicals were eliminated from the ERA because maximum concentrations were less than background, upgradient, or published concentrations for Massachusetts lakes and ponds, it is anticipated that potential risks from these chemicals are negligible, or are representative of general conditions of the area.

Tables 9-47 through 9-53 depict the CPC selection process for surface soil, surface water, and sediment at Areas 2 and 3 of AOC 57. For those chemicals eliminated as CPCs (excluding the essential nutrients), summary statistics and RME and average exposure concentrations are presented in Appendix O-3, Tables O-3.1 through O-3.6. Risks to ecological receptors were evaluated for these chemicals by the same processes outlined for those chemicals retained as CPCs in the baseline ERA.

Food chain risks for terrestrial and semi-aquatic wildlife were quantified for chemicals eliminated as CPCs using the same representative wildlife receptors and exposure assumptions as for chemicals retained as CPCs. The results of this evaluation are presented in Tables O-4.1 through O-4.10 in Appendix O-4 and summarized in Table O-3.7 in Appendix O-3. These results indicate that wildlife receptors are not at risk from exposure to chemicals eliminated as CPCs because all HIs are less than 1. When combined with the HIs calculated for CPCs that were retained in the ERA, the additional risk to wildlife receptors are negligible (Table O-3.7). For both Area 2 upland and Area 3 surface soil, the combined HIs for the American robin slightly exceed or are equal to 1; population-level effects are not likely to occur for small omnivorous bird populations at these low risk levels. This evidence indicates that terrestrial and semi-aquatic wildlife receptors are not at risk from exposure to chemicals eliminated as CPCs in surface soil, surface water, and sediment.

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Potential risks to terrestrial plants and soil invertebrates were evaluated for chemicals eliminated as CPCs in surface soil by the same method as for chemicals retained as CPCs. The results of this evaluation, which are shown in Tables O-3.8 through O-3.10 for Area 2 upland, Area 2 floodplain, and Area 3 (respectively) indicate that soil invertebrates are not at risk from exposure to chemicals However RME and average exposure eliminated as surface soil CPCs. concentrations of aluminum, chromium, and vanadium all exceed phytotoxicity benchmarks by approximately 2, 1, and 1 orders of magnitude (respectively). The phytotoxicity benchmarks for aluminum, chromium, and vanadium were derived by the Oak Ridge National Laboratory (Will and Suter, 1994) by selecting the 10th percentile value of rank ordered LOEC values obtained from studies using sensitive crop species (e.g., soybean, lettuce, tomato, oats, and clover). Unfortunately, few studies for these chemicals were available (n=1, 7, and 2 for aluminum, chromium, and vanadium, respectively). Consequently, the authors assigned a low level of confidence to these benchmarks, suggesting that there is a high degree of uncertainty associated with these phytotoxicity benchmarks. Furthermore, background values for aluminum, chromium, and vanadium in Devens soil exceed the phytotoxicity benchmarks by higher factors (360, 33, and 16, respectively), suggesting that the phytotoxicity benchmarks are overly conservative for this region. These benchmarks have not changed since this document was updated in 1997 (Efroymson et al., 1997). This evidence indicates that terrestrial plants and soil invertebrates are not at risk from exposure to chemicals eliminated as CPCs in surface soil.

Potential risks to aquatic receptors were evaluated for chemicals eliminated as CPCs in surface water and sediment by the same method as for chemicals retained as CPCs. Manganese at Area 3 was the only analyte eliminated as a CPC in surface water. A comparison of the Area 3 manganese RME and average exposure concentrations with the surface water benchmark, presented in Table O-3.11 in Appendix O-3, indicates that aquatic organisms are not at risk. Tables O-3.12 and O-3.13 in Appendix O-3 show a comparison of sediment concentrations of chemicals eliminated as CPCs with sediment benchmarks. These comparisons indicate that RME and average exposure concentrations of cadmium in Area 2 sediment, and arsenic, barium, and lead (RME only) in Area 3 sediment exceed the most conservative sediment benchmarks by factors of approximately 4, 6, 3, and 2 (respectively). Upgradient concentrations of arsenic, barium, and lead

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exceed these benchmarks by factors of approximately 18, 5, and 7 (respectively). Under laboratory toxicity test conditions, aquatic organisms experienced no adverse effects when exposed to sediment from Area 2 containing much higher concentrations of these metals, suggesting that the sediment benchmarks are overly conservative for evaluating risk at AOC 57. This evidence indicates that aquatic organisms are not at risk from exposure to chemicals eliminated as CPCs in surface water and sediment.

Risks to wildlife receptors from food chain exposures have been evaluated separately in the baseline ERA based on habitat preferences and/or Area boundaries. There is uncertainty about the additive risks to certain wildlife receptors (e.g., the barred owl and red fox) with large home ranges that may forage in contiguous suitable habitats. To address this uncertainty, the HIs calculated for these receptors from exposure to chemicals retained (RME and average) and eliminated (RME only) as CPCs have been summed in Table O-3.7 to estimate their additive risks:

Receptor (exposure)	<u>Area 2 Upland</u>	<u>Area 2 Floodplain</u>	<u>Area 3</u>	Additive Risk
Barred owl (RME)	0.00032	0.00032	0.00038	0.0010
Barred owl (Average)	0.00013	0.00011	0.00017	0.00041
Red fox (RME)	0.00011	NA	0.0011	0.0012
Red fox (Average)	0.000045	NA	0.00030	0.00035

As can be seen, wildlife receptors that forage in contiguous suitable habitats are not at risk from additive exposures.

- The food-web modeling results suggest that adverse effects to wildlife receptors from exposure to surface soil may occur from RME concentrations of arsenic. However, given the conservative nature by which risks were estimated, it is unlikely that wildlife receptors are at risk. Specifically, the finding that background arsenic levels are also associated with risk indicate that the reference studies used in support of RTV derivation are unduly conservative. In addition, ecological receptors are highly unlikely to be chronically exposed to maximum contaminant concentrations. And, as previously discussed, the contaminants with the greatest HQs are mechanistically distinct, such that combining risks (i.e., HQs) is overly conservative.
- There is uncertainty associated with the food chain risk estimates for wildlife, specifically associated with the exposure concentrations. The risk estimates were

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calculated using data generated in 1995 and 1996 for the RI, and also using data generated in 1998 and 1999 in response to regulator comments on the Draft RI. While using data from all four years is appropriate, the analytical programs varied slightly in the methods used and detection limits achieved. There was also some variation in the target analyte lists, such that some chemicals analyzed in 1995 were not analyzed in 1998, and vice versa. This may present some uncertainty in the BERA.

- There is uncertainty associated with the analytical results for arsenic. The arsenic results for soil at locations 57S-98-07X and 57S-98-08X has been qualified as estimated because the percent moisture in these samples was greater than 30 percent. It is possible that the arsenic results may be biased high.
- Risks to terrestrial receptors associated with exposure to TPHC, diesel fuel, and EPH/VPH in surface soil, surface water, and sediment may have been underestimated. Although selected as a CPC for these media, TPHC was not evaluated in the BERA because there are no toxicological benchmarks. TPHC was detected at concentrations in surface soil ranging from 5,100 to 41,000 μ g/g, in surface water at concentrations ranging from 250 to 920 μ g/L, and in sediment at concentrations ranging from 270 to 3,200 μ g/g.
- Risks to avian species may have been over- or under-estimated because bioaccumulation and toxicity data for this taxonomic group are generally lacking in the literature. To estimate risks to avians at AOC 57, mammalian data were used as surrogate values when avian data were lacking; however, there are additional uncertainties associated with extrapolations between these two taxa due to differing life stages and physiological parameters.
- Risks to plants and invertebrates may have been under-estimated because phytotoxicity and invertebrate benchmarks for several analytes are lacking. Specifically, potential risks to plants from exposure to TPHC and trichlorofluoromethane, and potential risks to invertebrates from exposure to antimony, barium, cobalt, manganese, selenium, PCBs, dibenzofuran, trichlorofluoromethane, and TPHC could not be evaluated.
- There is uncertainty associated with using unfiltered surface water data for evaluating risk to aquatic organisms from exposure to inorganic analytes. Risks to

aquatic organisms may have been over-estimated because unfiltered data represent the total fraction of analytes that occur in the water column, including those that are sorbed to particulates. In particular, there is uncertainty associated with the concentrations of unfiltered metals detected at sample location 57D-95-04X; the turbidity of this sample was high (504,000 μ g/L) and many of the metals (including cadmium, chromium, copper, mercury, and vanadium) were not detected in any other filtered or unfiltered sample. The risk estimates for filtered surface water suggest that aquatic receptors are unlikely to exhibit adverse effects.

- No sediment benchmarks exist for aluminum, cobalt, selenium, trichlorofluoromethane, diesel fuel, or TPHC gas fraction; therefore, risks to aquatic organisms from exposure to these analytes remain an uncertainty. In the absence of acid volatile sulfide data, the bioavailability of metals and TPHCs to exposed species is unknown.
- There is uncertainty associated with the control results in the amphipod (*H. azteca*) toxicity test. Only 64 percent survival was observed in the control sample, as opposed to the recommended minimum of 80 percent. These low survival rates may be attributable to stress to the organisms from shipment from the supply vendor, or possibly from contaminated control sediments collected by the toxicity test laboratory. Although control survival was below acceptable levels, amphipod survival in site samples was not significantly less than amphipod survival observed in the upstream reference location. Therefore, conclusions regarding risks to aquatic life at AOC 57 can be made based on a comparison with the reference results, rather than the control results.
- There is uncertainty associated with the bioaccumulation study performed using the freshwater oligochaete, *Lumbriculus variegatus*. Uncertainties center around several issues, including 1) the reliability of the chemical analysis resulting from sample mishandling, and 2) the detection of aldrin in oligochaete tissue, which may be associated with laboratory equipment contamination or elevated detection limits due to inadequate sample size. Because of the uncertainties surrounding this study, the results were not used in the assessment.
- There is uncertainty associated with the TPHC results for sediment in Cold Spring Brook. The data review performed on chemical analysis revealed that the TPHC concentrations may be biased low (i.e., concentrations of TPHC in Cold Spring

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Brook may be higher).

• Risks for analytes detected in the method blanks, trip blanks, and rinseate blanks may have been over-estimated. In particular, there were phthalates, acetone, and chlorinated solvents detected in method blanks associated with water samples, and phthalates, TPHC, and various VOCs detected in method blanks associated with solid media. In addition, several chlorinated solvents, bis(2-ethylhexyl)phthalate, mercury, lead, iron, potassium, and manganese were detected in rinseate blanks, and several chlorinated solvents were detected in trip blanks.

9.2.8 Summary of BERA for AOC 57

Potential risks for ecological receptors were evaluated for CPCs in surface soil, surface water, sediment, and groundwater at AOC 57. The following items summarize the results of the AOC 57 BERA:

- mercury was detected in only one unfiltered surface water sample, and not at all in filtered surface water. The detection in the one unfiltered sample raises uncertainty about the bioavailability of mercury in Area 2 surface water. There are also doubts about the origin of mercury in the one sediment sample in which it was detected. Furthermore, the RTV used to evaluate avian risks for mercury was based on a study using methyl mercury; this RTV may have over-estimated potential risks to wading birds because methyl mercury is not associated with AOC 57. These factors create significant uncertainty regarding the conclusion of the BERA that wading birds may be at risk from exposure to mercury from Area 2 surface water or sediment that may bioaccumulate in fish tissue;
- a survey of Area 2 showed no sign of contaminant induced stress to wetland or terrestrial vegetation, although the BERA indicated that there may be a risk to terrestrial plants from exposure to lead in Area 2 floodplain surface soil;
- analyses of surface water samples indicate that unfiltered concentrations of metals are elevated at both Areas 2 and 3; however, these concentrations may be related to the high turbidity of the samples, and may not be bioavailable to ecological receptors. Therefore, there is uncertainty regarding the finding that aquatic organisms may be at risk from iron in surface water at 57D-95-05X (located adjacent to Area 2);

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• while potential risks were also identified for benthic macroinvertebrates from exposure to metals, pesticides, PCB, and PAHs in Areas 2 and 3 sediment based on conservative benchmark comparisons, this conclusion is not supported by the apparent lack of adverse effects in bulk sediment toxicity studies. Benthic macroinvertebrates may be at risk from copper and lead concentrations in sediment at sample location 57D-95-04X (concentrations of these analytes may be correlated with observed adverse growth responses for *C. tentans* in toxicity tests).

Based on a comparison of surface water data with upgradient groundwater data, Cold Spring Brook surface water in the vicinity of Area 2 may be impacted by groundwater discharge. However, there does not appear to be a risk to aquatic receptors from the chemicals common to both these media. Groundwater at Area 3 does not appear to be impacting downgradient surface water in the floodplain of Cold Spring Brook, based on the difference in chemicals detected in these media.

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10.0 CONCLUSIONS AND RECOMMENDATIONS

RI activities were conducted by HLA personnel at AOC 57 Areas 2 and 3 to evaluate the nature and distribution of the groundwater and soil contamination detected during previous investigations. Conclusions developed from the RI findings are presented in the following subsections.

10.1 CONCLUSIONS

The following conclusions are based on interpretation of data collected from previous investigations and the RI completed at AOC 57. Tables 10-1 and 10-2 summarize the results of the Human Health and Ecological Risk Assessments.

AOC 57

- The geologic setting at AOC 57 includes a partially reworked soil/fill above the floodplain underlain by glacially deposited silty sand and sand. Surficial floodplain deposits include silt and silty sand underlain by discontinuous organic layers, sand, and silty sand. Bedrock was not encountered at AOC 57 but evidence suggests that depth to bedrock may be approximately 100 to 150 feet bgs.
- For the purpose of this RI the hydrogeologic condition at AOC 57 is dominated by the overburden aquifer. The water table is found in the overburden sands and silty sands. Local groundwater flow is primarily to the south southeast.

Area 1

- Area 1 consists of an eroded drainage ditch and storm drain outfall south of Barnum Road.
- A contaminated soil removal was performed in 1997 to address PAHs in soil. Following the removal action, Area 1 was recommended for no further action.

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• In accordance with recent USEPA requirements, an assessment for future unrestricted land use has been included in this RI. The assessment indicated that there are no unacceptable risks for future unrestricted land use.

Area 2

- Groundwater in the overburden aquifer at Area 2 discharges to Cold Spring Brook and its associated wetlands. The wetlands act to cause a convergence of groundwater flowpaths.
- Estimates of Area 2 hydraulic conductivities range between 1×10^{-1} cm/sec $(2 \times 10^{-1} \text{ ft/min})$ and 4×10^{-4} cm/sec $(8 \times 10^{-4} \text{ ft/min})$ with a geometric mean of 2×10^{-2} cm/sec $(3 \times 10^{-2} \text{ ft/min})$. A groundwater flow velocity of 1.6 feet per day was calculated using the geometric mean of estimated hydraulic conductivities and horizontal hydraulic gradients.
- Evidence suggests that the contaminant source is contaminated soils located in the vicinity of the previous soil removal excavation. Contaminated soils are attributed to the historical disposal of vehicle maintenance waste.
- Soil contamination was detected both on the flat northern portion of the site and in the Cold Spring Brook floodplain. Contamination in the northern portion of the site is primarily TPHCs and is located in the surficial soils. Soil contamination in the floodplain is localized along the southern perimeter of the soil removal excavation. Detected contaminants consist primarily of PCE, TCE, toluene, Aroclor, and TPHC.
- Chlorinated VOCs were detected in field analytical groundwater samples as well as off-site analytical groundwater samples. Specific contaminants observed include PCE, TCE, and toluene. The higher detections were observed in monitoring wells 57M-95-04A, 57M-95-07X, and 57M-95-08A and the piezometer 57P-98-02X all located along the southern portion of the site adjacent to Cold Spring Brook. Elevated levels of arsenic detected in groundwater are due to the mobilization of naturally occurring arsenic in soils.

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- Soil and groundwater contaminant distributions appear to be vertically located in the vicinity of the water table.
- Near shore surface water and sediment samples collected from the Cold Spring Brook wetlands adjacent to Area 2 were shown to contain similar chlorinated solvents as were found in Area 2 soils and groundwater. Discharge to the wetlands appears to be primarily located in the area of 57D-95-05X and 57D-98-01X located southwest of the removal excavation. Analytical data indicates that Area 2 is not impacting downstream portions of Cold Spring Brook. Distribution of TPHC, arsenic, and other inorganics within the Cold Spring Brook stream channel suggest an alternate upgradient source for the analytes. Elevated concentrations of TPHC, arsenic, and lead were detected in the area of the brook upstream from Area 2.
- Human health risk evaluations were performed for assumed exposure conditions for both the Area 2 Industrial Land Use scenario (upland) and the Recreational Land Use scenario (wetland).
- The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern (CPCs) identified in surface soil and subsurface soil included arsenic, iron, manganese, Aroclor-1260, and petroleum compounds such as EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations.
- Exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with current land use conditions are within acceptable levels established by the USEPA.
- The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and

groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Estimated cancer and non-cancer risks associated with future commercial/industrial development and use of upland areas of the site were within acceptable levels established by the USEPA.

- Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use and were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with future open space use of the wetland areas of the site were within acceptable levels established the USEPA. However, non-cancer risks associated with excavation of Area 2 wetland subsurface soils exceeded a hazard index of 1 for potential effects to the immune system. A HI of 1 is the threshold value applied by USEPA to evaluate the significance of non-cancer rises. These non-cancer risks were primarily attributable to Aroclor-1260 detected in soil samples at the toe of the Area 2 soil removal excavation.
- To aid in risk management decision-making at Area 2, future unrestricted use exposure was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil and groundwater). Non-cancer risks for potential exposures to soils, and cancer and noncancer risks for potential exposures to groundwater used as potable water, exceeded the USEPA acceptable risk limits. Groundwater risks were primarily attributable to arsenic; if the CSF for arsenic is adjusted downward by one order of magnitude (to account for uncertainty, as acknowledged by USEPA), the groundwater cancer risks would be within the USEPA acceptable cancer risk range. Future potable uses of AOC 57 groundwater is highly unlikely.

Potential risks for ecological receptors were evaluated for CPCs in surface soil, surface water, sediment, and groundwater at AOC 57. The following items summarize the results of the AOC 57 BERA:

• Mercury was detected in only one unfiltered surface water sample at Area 2, and not at all in filtered surface water. The detection in the one unfiltered sample raises uncertainty about the bioavailability of mercury in Area 2

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surface water. There are also doubts about the origin of mercury in the one sediment sample in which it was detected. These factors create significant uncertainty regarding the conclusion of the BERA that wading birds may be at risk from exposure to mercury from Area 2 surface water or sediment that may bioaccumulate in fish tissue;

- A survey of Area 2 showed no sign of contaminant induced stress to wetland or terrestrial vegetation, although the BERA indicated that there may be a risk to terrestrial plants from exposure to lead in Area 2 floodplain surface soil;
- Analyses of surface water samples indicate that unfiltered concentrations of metals are elevated at both Areas 2 and 3; however, these concentrations may be related to the high turbidity of the samples, and may not be bioavailable to ecological receptors. Therefore, there is uncertainty regarding the finding that aquatic organisms may be at risk from iron in surface water at 57D-95-05X (located adjacent to Area 2);
- While potential risks were also identified for benthic macroinvertebrates from exposure to metals, pesticides, PCB, and PAHs in Areas 2 and 3 sediment based on conservative benchmark comparisons, this conclusion is not supported by the apparent lack of adverse effects in bulk sediment toxicity studies. Benthic macroinvertebrates may be at risk from copper and lead concentrations in sediment at sample location 57D-95-04X (concentrations of these analytes may be correlated with observed adverse growth responses for *C. tentans* in toxicity tests).
- Based on a comparison of surface water data with upgradient groundwater data, Cold Spring Brook surface water in the vicinity of Area 2 may be impacted by groundwater discharge. However, there does not appear to be a risk to aquatic receptors from the chemicals common to both these media.

Area 3

• Estimates of Area 3 hydraulic conductivities range between $6x10^{-3}$ cm/sec $(1x10^{-2} \text{ ft/min})$ and $7x10^{-4}$ cm/sec $(1x10^{-4} \text{ ft/min})$ with a geometric mean of $2x10^{-3}$ cm/sec $(4x10^{-3} \text{ ft/min})$. A groundwater flow velocity of 0.34 et per

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day was calculated using the geometric mean of estimated hydraulic conductivities and horizontal hydraulic gradients.

- The identified contaminant source in Area 3 is a disposal area in the vicinity of test pit 57E-95-24X. The disposal area was bounded by test pits 57E-96-28X through 57E-96-31X which encountered assorted vehicle maintenance debris and sawdust.
- Soil contamination at Area 3 includes the VOCs PCE, TCE, toluene, ethylbenzene and xylenes. Detected SVOCs are primarily naphthalene, 1,2-DCB, and 1,4-DCB. In addition, Aroclor and TPHC were detected in source area and downgradient soils.
- Field screening and off-site analyses of groundwater samples indicate that the groundwater contamination is located primarily from the source area in the vicinity of test pit 57E-95-24X south to the monitoring well 57M-96-11X. Contaminants observed in this area include inorganics, VOCs and SVOCs. Elevated levels of cadmium and arsenic were observed in 57M-95-03X and 57M-96-11X, respectively. Piezometers 57P-98-03X and 57P-98-04X located downgradient of 57M-96-11X showed much decreased levels of arsenic in groundwater. Detected VOCs include TEX, TCE, and PCE. Low levels of chlorobenzene and ethylbenzene were the only VOCs detected in the downgradient piezometers. SVOCs are significant groundwater contaminants at Area 3. SVOCs detected consist of 1,2-DCB, 1,4-DCB, and naphthalene. These SVOCs were detected at both the source area well 57M-95-03X and the downgradient well 57M-96-11X. No pesticides, PCBs, or TPHC were detected in Area 3 groundwater.
- Downgradient soil and groundwater distribution of contaminants appears to be vertically localized in the vicinity of the water table. Deeper overburden wells were not installed; however, the proximity to Cold Spring Brook and observed contaminant levels indicate that vertically downward contaminant migration is unlikely.
- Sediment sampling showed that inorganics, VOCs, SVOCs, and petroleum contaminants were consistent with contamination in soils and groundwater. Contaminant concentrations were generally highest near the southern

terminus of the removal excavation (57D-98-05X) and decreased or were nondetect further into the wetland. Contaminant distributions in the wetland and Cold Spring Brook indicate that Area 3 is not impacting Cold Spring Brook.

- The Area 3 source area soil removal eliminated the majority of Area 3 soil contaminants. Confirmatory sampling indicates that residual EPH, PCBs, and pesticides are present near the southern end of the excavation.
- Observed arsenic concentrations in groundwater are believed to be due to reducing conditions in the aquifer. The reducing conditions are attributed to the aerobic degradation of the site contaminants.
- The risk assessment evaluated post-removal action conditions for surface soil and subsurface soil. Chemicals of potential concern identified in surface soil and subsurface soil primarily included arsenic, iron, manganese, Aroclor-1260, and petroleum compounds such as EPH and VPH hydrocarbon fractions. CPCs identified in groundwater, surface water, and sediment were similar to those identified in soil, but also included chlorinated VOCs, which were detected at low concentrations.
- Exposures and risks for current site use were evaluated for a site maintenance worker (possible exposure to surface soil), and a trespasser ages 6 through 16 (possible exposure to surface soil, surface water, and sediment). Estimated cancer and non-cancer risks associated with current land use conditions are within acceptable levels established by the USEPA.
- The possible health risks associated with the anticipated future site use were evaluated assuming that the upland portion of the site will be redeveloped for commercial/industrial use, and included evaluation of a commercial industrial worker (possible exposure to surface soil and groundwater) and an excavation worker (possible exposure to surface soil and subsurface soil). Possible health risks for the future use of the wetland areas were evaluated assuming that the areas could be used for passive recreational/open space use and were evaluated for a recreational child ages 6 through 16 (possible exposure to surface soil, surface water, and

sediment). Estimated cancer and non-cancer risks associated with future open space use of the wetland areas of the site were within acceptable levels established the USEPA. With the exception of potable use of Area 3 groundwater, estimated cancer and non-cancer risks associated with future commercial/industrial development and use of upland areas of the site were within acceptable levels established by the USEPA.

• To aid in risk management decision-making and to determine if additional response actions may be required at AOC 57, future unrestricted land use was evaluated by assuming that child and adult residents would live at the site (possible exposures to surface soil and groundwater). Non-cancer risks for potential exposures to soils at the Area 3 wetlands, and cancer and non-cancer risks for potential exposures to groundwater used as potable water, exceeded the USEPA acceptable risk limits. Groundwater risks were primarily attributable to arsenic; if the CSF for arsenic is adjusted downward by one order of magnitude (to account for uncertainty, as acknowledged by USEPA), the groundwater cancer risks would be within the USEPA acceptable cancer risk range.

10.2 RECOMMENDATIONS

Based on the results and interpretation of the physical and chemical data and taking into account the future use of this AOC, HLA recommends the following actions:

- Following the 1997 removal action and subsequent unrestricted land use risk assessment, Area 1 is recommended for no further action.
- Based upon the conclusions of the RI and the Human Health Risk Assessment, HLA recommends that a Feasibility Study be performed to evaluate alternatives to remove possible human health risks associated with potential future exposure to wetland soils by an excavation worker at Area 2 and hypothetical future residential exposures to soil and groundwater.
- Based on the results and interpretations of the RI and the Human Health Risk Assessment, HLA recommends that a Feasibility Study be performed to evaluate alternatives to remove potential human health risks associated

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with potential future potable use of Area 3 groundwater and hypothetical future residential exposures to soil and groundwater.

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ARFAnalysis Request FormARARapplicable or relevant and appropriate requirementsASTaboveground storage tankATECATEC Environmental Consultants, Inc.BAFsbioaccumulation factorsBCFsbioconcentration factorsbgsbelow ground surfaceBNAbase neutralized acidsBRACBase Realignment and ClosureBRACBase Realignment and Closure Environmental EvaluationBTEXbenzene, toluene, ethylbenzene, and xylene°Cdegrees Celsiuscm/seccentimeters per secondCERCLAComprehensive Environmental Response, Compensation and Liability ActCFRCode of Federal RegulationsCLPContract Laboratory ProgramCMRCode of Massachusetts RegulationsCOCchain-of-custodyCORContract Laboratory ProgramCORContract Laboratory Program
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COC chain-of-custody
COK Contracting Officer's Representative
CPC chemical of potential concern
CRL Certified Reporting Limits
CSF cancer slope factor
1.2-DCA 1.2-dichloroethane
DCE 1.1-dichloroethene
DDT dichlorodiphenyl trichloroethane
DOT Department of Transportation
DOO Data Quality Objective
DRO Diesel Range Organics

DWEL	Drinking Water Equivalency Level
ECD	electron capture detector
E&E	Ecology & Environment, Inc.
ED	exposure duration
EE	Environmental Evaluation
EE&G	Environmental Engineering and Geotechnics
ELCD	electronic conductivity detector
ELCR	excess lifetime cancer risk
EMO	Environmental Management Office
EPC	exposure point concentration
EPH	Extractable Petroleum Hydrocarbons
ER-L	effects range-low
ER-M	effects range-medium
ESE	Environmental Science and Engineering, Inc.
ETA	Engineering Technologies Associates
ft/ft	feet per foot
ft/min	feet per minute
ft/day	feet per day
ft²/day	square feet per day
٥Ŀ	degrees Fahrenheit
FFA	Federal Facilities Agreement
FID	flame ionization detector
FS	Feasibility Study
FSP	Field Sampling Plan
GC/MS	gas chromatograph/mass spectrometer
g/mL	grams per milliliter
gpm	gallons per minute
GPR	ground-penetrating radar
GRO	gasoline range organics
H	Henry's Law Constant
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Table
HI .	hazard index

HQ	hazard quotient
HSA	hollow-stem augers
IAG	Inter Agency Agreement
\mathbb{D}	inside diameter
IDW	investigation-derived waste
IR.	infrared spectrophotometer
IRDMIS	Installation Restoration Data Management Information System
IRIS	Integrated Risk Information System
kg	kilograms
K _{oc}	organic carbon partition coefficient
LEL	lowest effect level
LOAEL	lowest observed adverse effects level
m^3	cubic meters
MAAF	Moore Army Air Field
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MCP	Massachusetts Contingency Plan
MDL	Method Detection Limits
MEP	Master Environmental Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
MMCL	Massachusetts Maximum Contaminant Level
MNHP	Massachusetts Natural Heritage Program
mph	miles per hour
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean seal level
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
ND	non-detect

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NDIR	non-dispersed infrared
NFA	no further action
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effects level
NWR	National Wildlife Refuge
OD	outside diameter
OME	Ontario Ministry of the Environment
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAH	polynuclear aromatic hydrocarbon
PAL	Project Analyte List
PARCC	precision, accuracy, representativeness, completeness, and comparability
PC	personal computer
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PDE	potential dietary exposure
PID	photoionization detector
POP	Project Operations Plan
ppb	parts per billion
ppm	parts per million
POL	Practical Quantitation Limit
PRE	preliminary risk evaluation
PRI	Potomoc Research, Inc.
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure
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ROD	Record of Decision
RPD	relative percent difference
RTV	reference toxicity value
SA	Study Area
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SFF	site foraging frequency
SI	Site Investigation
SMCL	Secondary Maximum Contaminant Level
SQG	sediment quality guidelines
SQL	sample quantitation limit
SVOA	semivolatile organic analysis
SVOC	semivolatile organic compound
TBC	to be considered
1,1,1-TCA	1,1,1,-trichloroethane
1,1,2,2-TCA	1,1,2,2-trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TDS	total dissolved solids
TEX	toluene, ethylbenzene and xylenes
TIC	tentatively identified compounds
TPHC	total petroleum hydrocarbons
TOC	Total Organic Carbon
TSCA	Toxic Substance Control Act
TSS	total suspended solids
μg/g	micrograms per gram
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
µg/ml	micrograms per milliliter
μĹ	microliter
UCL	upper confidence limit
UF	uncertainty factors

USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Center
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VC	vinyl chloride
VPH ·	volatile petroleum hydrocarbons
VOA	volatile organic analysis
VOC	volatile organic compound
WPA	Works Progress Administration

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- ABB Environmental Services, Inc., 1996a. "Final Task Order Work Plan Area of Contamination (AOC) 57, AOC 63AX, and AOC 69W;" Data Item A002; Prepared for Commander. U.S. Army Environmental Center; Prepared by ABB Environmental Services, Inc., Portland, Maine; January 1996.
- ABB Environmental Services, Inc., 1996b. "Final Task Order Work Plan Addendum for Area of Contamination 57;" Task Order No. 1, Modification No. 1; Prepared for Commander. U.S. Army Environmental Center; Prepared by ABB Environmental Services, Inc., Wakefield, Massachusetts; August 1996.
- ABB Environmental Services, Inc., 1995a. "Revised Final Site Investigation Report -Groups 2, 7, and Historic Gas Stations, Fort Devens, Massachusetts"; Data Item A009; prepared for Commander, U.S. Army Environmental Center; prepared by ABB Environmental Services, Inc., Portland, Maine; October 1995.
- ABB Environmental Services, Inc., 1995b. "Final Project Operations Plan for Site Investigations and Remedial Investigations, Fort Devens, Massachusetts"; Data Item A005/A008; prepared for Commander, U.S. Army Environmental Center; prepared by ABB Environmental Services, Inc., Portland, Maine; May 1995.
- ABB Environmental Services, Inc., 1995c. "Lower Cold Spring Brook Site Investigation Report, Fort Devens, Massachusetts"; Data Item A009; prepared for Commander, U.S. Army Environmental Center; prepared by ABB Environmental Services, Inc., Portland, Maine; December 1995.
- ABB-ES, 1993a. Biological and Endangered Species Baseline Study, Fort Devens, Massachusetts; prepared for U.S. Army Corps of Engineers New England Division Waltham, Massachusetts.
- ABB-ES, 1993b. Draft Remedial Investigation Addendum Report Data Item A009, Fort Devens Group 1 A, Massachusetts; prepared for U.S. Army Environmental Center, Aberdeen Proving Ground, Maryland.
- Alden, W.C., 1925. "Physical Features of Central Massachusetts." In Contributions to the Geography of the United States, 1923-1924. U.S. Geological Survey Bulletin 760, pp. 13-106.

American Cancer Society (ACS(, 1997, "Cancer Facts and Figures".

- Arthur D. Little, Inc. (ADL), 1994a. Final Storm Sewer System Evaluation (AREE 70) Evaluation. Base Realignment and Closure Environmental Evaluation. Fort Devens, Massachusetts. Prepared for the U.S. Army Environmental Center (AEC). June 1994.
- Arthur D. Little, Inc. (ADL), 1994b. Addendum 1 AREE River Evaluation. Base Realignment and Closure Environmental Evaluation. Fort Devens, Massachusetts. Prepared for the U.S. Army Environmental Center (AEC). Rev 2 June.
- Aquatic Information Retrieval System (AQUIRE), 1996. USEPA On-line Aquatic Database Record Search; April, (Toxicity Data) and July, (Bioconcentration Factors).
- Audubon, 1994. <u>National Audubon Society Field Guide to North American Birds</u>; Borzoi Books, Chanticleer Press, Inc., New York, NY.
- Baes, C.F. III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture"; Oak Ridge National Laboratory; ORNL-5786; September 1984.
- Bailey, N.J.L, A.M. Jobson, and M.A. Rogers, 1973. "Bacterial Degradation of Crude Oil: Comparison of field and Experimental Data"; *Chemical Geology*; Vol. II; pp. 203-211.
- Baker, R.H., 1983. Michigan Mammals; Michigan State University Press; 642 pp.
- Barbour, F. A., c. 1941. "Fort Devens, Mass. General Layout Plan"; Plan 6101-710.1B; prepared for Construction Division, Office of Quartermaster General; Scale approximately 1:7,000.
- Barnthouse, L.W., J.E. Breck, T.D. Jones, G.W. Suter II, C. Easterly, L.R. Glass, B.A. Owen, A.P. Watson, 1988. <u>Relative Toxicity Estimates and Bioaccumulation</u> <u>Factors for the Defense Priority Model</u>, Environmental Sciences Division, Oak

Ridge National Laboratory, Publication No. 2997, October 1988.

- Base Realignment and Closure Commission Plan (BRAC 91), 1994. PL 101-510. May 1994.
- Beyer, W.N., 1990. "Evaluating Soil Contamination"; U.S. Fish and Wildlife Service, Biological Report 90(2).
- Biang, C.A., R.W. Peters, R.H. Pearl, and S.Y. Tsai, 1992. "Master Environmental Plan for Fort Devens, Massachusetts"; prepared for U.S. Army Toxic and Hazardous Materials Agency; prepared by Argonne National Laboratory, Environmental Assessment and Information Sciences Division; Argonne, Illinois; April.
- Bouwer, H., and R.C. Rice, 1976. "Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells"; *Water Resources Research*; Vol. 12, No. 3; pp. 423-428.
- Brackley, R.A. and B.P. Hansen, 1977. "Water Resources of the Nashua and Souhegan River Basins, Massachusetts." U.S. Geological Survey Hydrologic Investigations Atlas HA-276.
- Briggs, G.G., R.H. Bromilow, and A.A. Evans, 1982, Relationships Between Lipophilicity and Root Uptake and Translocation of Non-ionized Chemicals by Barley; Pestic. Sci. (14) 495-504; January 1982.
- Briggs, G.G., R.H. Bromilow, A.A. Evans, and M. Williams, 1983. "Relationships Between Lipophilicity and the Distribution of Non-ionized Chemicals in Barley Shoots Following Uptake by the Roots"; <u>Pestic. Sci</u>. (14) 492-500; February, 1983.
- Burt, W.H., and R.P. Grossenheider, 1976. <u>A Field Guide to the Mammals</u>; Houghton and Mifflin Co., Boston, MA; 289 pp.
- DeGraaf, R.M., and D.D. Rudis, 1986. New England Wildlife: Habitat, Natural History, and Distribution; USDA Forest Service, Northeastern Forest Experiment Station, General Technical Report NE-108.

- Detrick, C.E., 1991. "Installation Assessment, Fort Devens, Ayer, Massachusetts"; prepared for U.S. Army Toxic and Hazardous Materials Agency; prepared by Environmental Photographic Interpretation Center, Environmental Monitoring Systems Laboratory, Warrenton, VA; September.
- Ecology and Environmental, Inc. (E&E), 1994. Final Remedial Investigations Report, Functional Area I, Fort Devens, Massachusetts (Volumes I through IV). Prepared by E&E for the U.S. Army Environmental Center (AEC). August 1994.
- Engineering Technologies Associates, Inc. (ETA), 1992. "Ground Water Flow Model at Fort Devens, Massachusetts." Prepared for Commander, U.S. Army Toxic and Hazardous Materials Agency. Ellicott City, Maryland: ETA. October 30.
- Engineering Technologies Associates, Inc. (ETA), 1996. "Analysis of Well Head Protection Area Delineation of Fort Devens Water Supply Wells, Addendum One of the Detailed Flow Model for the Main and North Post, Fort Devens, Massachusetts". Prepared for Commander, U.S. Army Environmental Center. Ellicott City, Maryland: ETA.
- Environmental Criteria and Assessment Office (ECAO), 1994a. "Derivation of a Provisional Oral RfD for Aluminum." U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.
- Environmental Criteria and Assessment Office (ECAO), 1994b. "Derivation of a Provisional Oral RfD for Iron." U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.
- Environmental Criteria and Assessment Office (ECAO), 1994c. "Derivation of a Provisional Oral RfD for Naphthalene." U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.
- Finley, B., D. Proctor, P. Scott, N. Harrington, D. Paustenback, P. Price, 1994. Recommended Distributions for Exposure Factors Frequently Used in Health Risk Assessments. Risk Analysis, Volume 14, No. 4, August 1994.
- Fitchko, J., 1989. "Criteria for Contaminated Soil/Sediment Cleanup"; Pudvan Publishing Co., Inc.; Northbrook, IL.

- Fort Devens Dispatch, 1992. "The Army in New England: 75 Years in the Making." Special Edition. Vol. 52, No. 34. September 10.
- Freeze, 1979. Freeze, R. Allan, J. A. Cherry, 1979. Groundwater: Englewood Cliffs, N.J., Prentice Hall, p. 29.
- Goyer, R.A., 1991. "Toxic Effects of Metals in Casarett & Doull's Toxicology." In The Basic Science of Poisons; 4th Ed.; Eds. Amdur, M.O., J. Doull and C.D. Klaassen; New York: Pergamon Press, Inc.
- Harding Lawson Associates (HLA), 1998. "Draft Supplemental Work Plan, AOC 57 Areas 2 and 3"; Portland, Maine, March 1998.
- Hodson and Williams. 1988. Average of values from The Estimation of the Adsorption coefficient (K_{oc}) for Soils by High Performance Liquid Chromatography. Chemosphere. 17(1):67-77.

Huling, S.G. 1989. "Facilitated Transport"; EPA/540/4-89/003, 5 p.

- Hvorslev, M.J., 1951. "Time Lag and Soil Permeability in Groundwater Investigations"; U.S. Army Corps of Engineers Waterways Experiments Station; Bulletin 36; Vicksburg, MS.
- Jahns, R.H., 1953. Surficial Geology of the Ayer Quadrangle, Massachusetts. Scale 1:31,680. U.S. Geological Survey.
- Jamison, V.W., R.L. Raymond, and J.O. Hudson, 1975. "Biodegradation of High Octane Gasoline in Groundwater"; *Developments in Industrial Microbiology*; Vol. 16; pp. 305-311.
- Keely, J.F. 1989. "Performance Evaluations of Pump-and-Treat Remediations"; U.S. EPA/540/4-89/005. 19 p.
- Kenaga, S.E., and C.A.I. Goring, 1978. "Relationship Between Water Solubility, Soil Sorption, Octanol-Water Partitioning, and Bioconcentration of Chemicals in Biota"; American Society of Testing Material; Third Aquatic Toxicity Symposium; New Orleans, Louisiana; p. 63.

- Kondakis, X.G., et al., 1989. "Possible Health Effects of High Manganese Concentration in Drinking Water." Arch. Environ. Health. 44:175-178.
- Koteff, C., 1966. "Surficial Geologic Map of the Clinton Quadrangle, Worcester County, Massachusetts." U.S. Geological Survey Map GQ-567.
- Kurz Associates, Inc., 1991. "Underground Storage Tank Removal and Related Environmental Investigations, Fort Devens Military Reservation, Harvard, Massachusetts"; prepared for Franklin Environmental Services, Inc., Wrentham, MA; Bridgewater, MA; January.
- Levine, M.B., A.T. Hall, G.W. Barrett, and D.H. Taylor, 1989. "Heavy Metal Concentrations During Ten Years of Sludge Treatment to an Old-Field Community"; J. Environ. Qual., Vol. 18, pgs. 411-418.
- Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder, 1994. <u>Incidence of Adverse</u> <u>Biological Effects within Ranges of Chemical Concentrations in Marine and</u> <u>Estuarine Sediments</u>; National Oceanic and Atmospheric Administration; September 15.
- Lyman, W. J., Reehl, W. F., and Rosenblatt, D. H. 1982. "Handbook of Chemical Property Estimation Methods." McGraw-Hill, Inc., New York.
- Mabey, W. R., Smith, J. H., Podoll, R. T., Johnson, H. L., Mill, T., Chou, T. W., Gates, J., Patridge, I. W., Jaber, H., and Vandenberg, D. 1982. "Aquatic Fate Process Data for Organic Priority Pollutants." Prepared by SRI International. Prepared for Monitoring and Data Support Division, Office of Water Regulations and Standards. Washington, D.C. EPA Contract Nos. 68-01-3867 and 68-03-2981.
- Mackay, D. and Shiu, W. Y. 1981. "A Critical Review of Henry's Law Constants for Chemicals of Environmental Interest." J. Phys. Chem. Ref. Data. 10:1175-1199.
- Mackay, D., Shiu, W. Y., Sutherland, R. P. 1979. Determination of air-water Henry's Law constants for hydrophobic pollutants. Environ. Sci. Technol. 13:333-337.

- Marcoa Publishing, Inc., 1990. "Welcome to Fort Devens A Community of Excellence." San Diego, California.
- Massachusetts Department of Environmental Protection (MADEP, 1995). "Revised Massachusetts Contingency Plan, 310 CMR 40.000. January 1995.
- Massachusetts Department of Environmental Protection, 1996. "Drinking Water Standards and Guidelines for Chemicals in Massachusetts Drinking Waters"; Office of Research and Standards, Boston, MA. May 1996.
- Massachusetts Department of Environmental Protection (MADEP), 1997. Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of MADEP VPH/EPH Approach. Public Comment Draft. September 25.
- Massachusetts Department of Environmental Protection (MADEP), 1998. "Method for the Determination of Volatile Petroleum Hydrocarbons (VPH)"; Division of Environmental Analysis; Office of Research and Standards; Bureau of Waste Site Cleanup; January 1998.
- Massachusetts Department of Environmental Protection (MADEP), 1998. "Method for the Determination of Extractable Petroleum Hydrocarbons (EPH)"; Division of Environmental Analysis; Office of Research and Standards; Bureau of Waste Site Cleanup; January 1998.
- Maughan, J.T., 1993. Ecological Assessment of Hazardous Waste Sites; New York, NY; Van Nostrand Reinhold; p. 352.
- McMaster, B.N., J.D. Bonds, J.H. Wiese, K.L. Hatfield, J.B. Holly, L.C. Carter, E.A. Knauft, and K.A. Civitarese, 1982. *Installation Assessment of Headquarters Fort Devens, Report No. 326.* Prepared for Commander, Headquarters Fort Devens and for U.S. Army Toxic and Hazardous Materials Agency. Prepared by Environmental Science and Engineering, Inc.. Gainesville, FL. August.
- Montgomery, J.H., 1991. "Groundwater Chemical Field Guide". Lewis Publishers, Chelsea, MI. 271 p.

- National Academy of Sciences (NAS), 1977. "Drinking Water and Health"; Safe Drinking Water Committee, Washington, D.C.
- National Research Council (NRC), 1982. "Nutrient Requirements of Minks and Foxes. Second Revised Edition, 1982"; Subcommittee on Furbearer Nutrition, National Academy Press, Washington, D.C.
- National Research Council (NRC), 1984. <u>Nutrient Requirements of Poultry</u>; Subcommittee on Poultry Nutrition; National Academy Press, Washington, D.C.
- NYSDEC, 1994. "Sediment Criteria"; Bureau of Environmental Protection, Division of Fish and Wildlife, NYSDEC; July, 1994.
- OHM Remediation Services Corp., 1995. Draft Removal Action Report Study Area 57 -Area 2. Fort Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers, New England Division, Waltham, Massachusetts, October 1995.
- Peck, J.H., 1975. "Preliminary Bedrock Geologic Map of the Clinton Quadrangle, Worcester County, Massachusetts." Scale 1:24,000; text and three maps. U.S. Geological Survey Open-File Report 75-658.
- Peck, J.H., 1976. "Silurian and Devonian Stratigraphy in the Clinton Quadrangle, Central Massachusetts." In Contributions to the Stratigraphy of New England. Geological Society of America Memoir 148.
- Persaud, D., R. Jaagumagi, and A. Hayton, 1996. "Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario"; Ontario Ministry of the Environment, Queen's Printer for Ontario; 23 pp.
- Potomac Research Inc. (PRI), 1993. User's Manual, IRDMIS PC Data Entry and Validation Subsystem. Version 5.0. Prepared for U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Maryland. February.
- Rand, G.M. and S.R. Petrocelli, 1985. <u>Fundamentals of Aquatic Toxicology: Methods</u> and <u>Applications</u>; Hemisphere Publishing Corporation, New York, 1985, 666 pp.

- Rathburn, R. E. and Tai, D. Y. 1982. "Volatilization of Ketones from Water." Water, Air and Soil Poll. 281-293
- Robinson, G.R., Jr., 1978. "Bedrock Geologic Map of the Pepperell Shirley, Townsend Quadrangles, and Part of the Ayer Quadrangle, Massachusetts and New Hampshire." Miscellaneous Field Studies Map MF-957. U.S. Geological Survey.
- Robinson, P. and R. Goldsmith, 1991. "Stratigraphy of the Merrimack Belt, Central Massachusetts." In *The Bedrock Geology of Massachusetts*. U.S. Geological Survey Professional Paper 1366-G. pp. 61-637.
- Rojko, A.M., 1990. "Heavy Metals in the Sediments of Massachusetts Lakes and Ponds." Unpublished Master's Thesis; Northeastern University: Department of Civil Engineering; June.
- Rowen, D.J., and J.B. Rasmussen, 1992. "Why Don't Great Lakes Fish Reflect Environmental Concentrations of Organic Contaminants? An Analysis of Between-lake Variability in the Ecological Partitioning of PCBs and DDT." J. Great Lakes Res.; 18(4): 724-741.
- Russell, S.L. and R.W. Allmendinger, 1975. "Interim Geologic Map of the Shirley Quadrangle, Massachusetts." U.S. Geological Survey Open File Report 76-267.
- Ryan, J.A., R.M. Bell, J.M. Davidson, and G.A. O'Connor, 1988. "Plant Uptake of Nonionic Organic Chemicals from Soils"; <u>Chemosphere</u>, Vol. 17, No. 12, pp. 2299-2323; 0045-6535/88; Great Britain; 1988.
- Shen, T. J. 1982. Air quality assurance for land disposal of industrial wastes. Environmental Management. 6:297-305.
- Soil Conservation Service, undated. "General Soil Map of Middlesex County, Massachusetts"; U.S. Department of Agriculture; Middlesex Conservation District; unpublished.
- Soil Conservation Service, 1985. "Soil Survey of Worcester County, Massachusetts, Northeastern Part"; U.S. Department of Agriculture.

- Soil Conservation Services, 1989. Untitled Middlesex County field sheet #19; U.S. Department of Agriculture; Middlesex Conservation District; January 5.
- Soil Conservation Service, 1991. "Middlesex County Massachusetts Interim Soil Survey Report"; U.S. Department of Agriculture; Middlesex Conservation District; Westford, MA (includes Soil Sheet #19).
- Suter, Glen W., 1993. Ecological Risk Assessment; Lewis Publishers, Chelsea Michigan.
- Tinsley, I.J., 1979. Chemical Concepts in Pollutant Behavior; John Wiley and Sons; New York, New York.
- Todd, D.K., 1980. <u>Groundwater Hydrology</u>; University of California, Berkeley and David Keith Todd, Consulting Engineers, Inc.; John Wiley & Sons, New York, New York. 1980.
- Travis, C.C., and A.D. Arms, 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetation"; Environ. Sci. Tech.; Vol. 22; 271-274.
- Tseng, W.P., H.M. Chu, S.W. How, J.M. Fong, C.S. Lin, and S. Yen, 1968. "Prevalence of Skin Cancer in an Endemic Area of Chronic Arsenicism in Taiwan." J. Natl. Cancer Inst. 40, No. 3, pp. 453-463.
- U.S. Army Environmental Center (USAEC), 1987. "Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports"; March 1987.
- U.S. Army Environmental Center, 1990. "Quality Assurance Manual"; Aberdeen Proving Ground, MD; January.
- U.S. Army Environmental Center (USAEC), 1990. "USAEC QA Program"; January 1990.
- U.S. Army Environmental Center, 1993. Fact Sheet: Fort Devens Installation Restoration Program (IRP) and BRAC 91 Environmental Restoration Impact. March.

- U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1990. *Quality* Assurance Program. USATHAMA PAM 11-41; Aberdeen Proving Ground, MD; January 1990.
- U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1990. *Quality* Assurance Program. PAM-41. January.
- U.S. Department of the Army, 1979. Environmental Impact Statement, Fort Devens Mission Activities, Fort Devens, Massachusetts. Headquarters, U.S. Army Forces Command. June 30; Revised May 1, 1980.
- U.S. Engineer Office, 1952. "Master Plan, Fort Devens, Ayer, Mass., Detail Site Plan, Building Use Map"; Sheets Nos. 6 through 21; Boston, MA; Files X100-109/705 through X100-109/720.
- U.S. Environmental Protection Agency (USEPA) Region I and the U.S. Department of the Army, 1991e. In the Matter of: The U.S. Department of the Army, Fort Devens Army Installation, Fort Devens, Massachusetts. Federal Facility Agreement Under the Comprehensive Environmental Response, Compensation, and Liability Act, Section 120. May 13.
- U.S. Environmental Protection Agency (USEPA), 1983. "Methods for the Chemical Analysis of Water and Wastes" Environmental Monitoring and Support Laboratory; USEPA 600-4-79-020; Cincinnati, OH; March 1983.
- U.S. Environmental Protection Agency (USEPA), 1983. Guidelines for Deriving Numerical Water Quality Criteria for the Protection of Aquatic Life and Its Uses. Draft. July.
- U.S. Environmental Protection Agency (USEPA), 1984. "Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring"; OWRS; QA-1; May 1984.
- U.S. Environmental Protection Agency (USEPA), 1986. "Test Methods for Evaluating Solid Waste:; Laboratory Manual Physical/Chemical Methods; Office of Solid Waste and Remedial Response; Washington, D.C., SW-846; November 1986.

- U.S. Environmental Protection Agency (USEPA), 1986. *Quality Criteria for Water* 1986. Office of Water Regulations and Standards, Washington, D.C., EPA 440/5-86-001. May 1, 1986.
- U.S. Environmental Protection Agency (USEPA), 1986. Superfund Public Health Evaluation Manual. Exhibit C-1.
- U.S. Environmental Protection Agency (USEPA), 1988a. "Region 1 Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses"; Hazardous Site Evaluation Division; November 1988.
- U.S. Environmental Protection Agency, 1988b. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA"; USEPA Office of Emergency and Remedial Response, EPA/540/G-89/004, OSWER Directive 9355.3-01; October.
- U.S. Environmental Protection Agency, 1988c. "Agency Policy on the Carcinogenic Risk Associated with Inorganic Arsenic"; memorandum from Lee M. Thomas, Office of the Administrator for Pesticides and Toxic Substances; Washington, D.C.; June 21.
- U.S. Environmental Protection Agency (USEPA), 1989a. "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response: EPA-540/1-89-002 (interim final); Washington, D.C., December.
- U.S. Environmental Protection Agency (USEPA), 1989a. "Transport and Fate of Contaminants in the Subsurface". EPA/625/4-89/019, 148 p.
- U.S. Environmental Protection Agency (USEPA), 1989b. <u>Exposure Factors Handbook;</u> Office of Health and Environmental Assessment; EPA-600/8-89/043; Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), 1989b. "Risk Assessment Guidance for Superfund". Volume I: Human Health Evaluation Manual. Interim Final. OSWER Directive 9285.7-01a. September 29, 1989. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/001.

- U.S. Environmental Protection Agency (USEPA), 1989c. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, D.C. July.
- U.S. Environmental Protection Agency (USEPA), 1989d. "Region 1 Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses;" Hazardous Site Evaluation Division; February 1989.
- U.S. Environmental Protection Agency (USEPA), 1990. Code of Federal Regulations, Title 40, Part 300, National Oil and Hazardous Substances Pollution Contingency Plan; Federal Register; March 8.
- U.S. Environmental Protection Agency (USEPA), 1990. "Basics of Pump-and-Treat Groundwater Remediation Technology"; Environmental Research Laboratory, Ada, OK, EPA/600/8-90/003.
- U.S. Environmental Protection Agency (USEPA), 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors", Office of Emergency and Remedial Response, Toxics Integration Branch; OSWER Directive 9285.6-03 (interim final); Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), 1991a. "National Functional Guidelines for Organic Data Review"; Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), 1991b. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual Supplemental Guidance. Standard Default Exposure Factors. Interim Final. Washington, D.C. OSWER Directive 9285.6-03. March 25, 1991.
- U.S. Environmental Protection Agency (USEPA), 1991c. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Publication 9298.7-013. December 1991 and Revision October 1992.
- U.S. Environmental Protection Agency (USEPA), 1992a. "Risk Updates"; USEPA Region I, Waste Management Division; December.

- U.S. Environmental Protection Agency (USEPA), 1992a. Guidelines for Exposure Assessment. Federal Register 57:22888-22938.
- U.S. Environmental Protection Agency (USEPA), 1992b. "Supplemental Guidance to RAGS, Calculating the Concentration Term". Office of Solid Waste and Emergency Response; Intermittent Bulletin, Vol. 1, No. 1; Washington, D.C.; May.
- U.S. Environmental Protection Agency (USEPA), 1992c. "Guidance for Data Usability in Risk Assessment (Parts A and B)"; Office of Emergency and Remedial Response; Publication 9285.7-09A; Washington, D.C.; April.
- U.S. Environmental Protection Agency (USEPA), 1992c. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development. EPA/600/8-91/011B. January.
- U.S. Environmental Protection Agency (USEPA), 1992d. Dermal Exposure Assessment: Principles and Applications; Office of Research and Development; EPA/600/9-91/011B; Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), 1993. Data Quality Objective Process for Superfund, Interim Final Guidance, EPA/540/G-93/071, Publication 9355.9-01, September 1993.
- U.S. Environmental Protection Agency (USEPA), 1994a. Region I Risk Updates Number 2. USEPA Region One Waste Management Division. August 1994.
- U.S. Environmental Protection Agency (USEPA), 1994b. "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities"; Office of Solid Waste and Emergency Response, OWSER Directive 9355.4-12; July 1994.
- U.S. Environmental Protection Agency (USEPA), 1995a. Risk Updates. Number 3. EPA New England. August 1995.

- U.S. Environmental Protection Agency (USEPA), 1995b. "Health Effects Assessment Summary Tables (HEAST)", Annual FY 1995. Office of Solid Waste and Emergency Response EPA/R-95-036, and the November 1995 Supplemental Update.
- U.S. Environmental Protection Agency (USEPA), 1995c. Supplemental Guidance to RAGS: Region 4 Bulletins, November.
- U.S. Environmental Protection Agency (USEPA), 1996. "Risk Updates"; USEPA New England, Waste Management Division; No. 4; November.
- U.S. Environmental Protection Agency (USEPA), 1996. "Test Methods for Evaluating Solid Waste"; Laboratory Manual Physical/Chemical Methods; Office of Solid Waste and Emergency Response; Washington, DC; SW-846; November 1986; Revision 4 -December 1996.
- U.S. Environmental Protection Agency (USEPA), 1996a. Risk-Based Concentration Table. Prepared by Roy L. Smith, USEPA Region III Technical Program Support Branch. April 19, 1996.
- U.S. Environmental Protection Agency (USEPA), 1996b. Drinking Water Regulations and Health Advisories. Office of Water, Washington, DC. February 1996.
- U.S. Environmental Protection Agency (USEPA), 1996c. "Integrated Risk Information System (IRIS); On-Line Service. June 1996.
- U.S. Environmental Protection Agency (USEPA), 1996d. <u>Soil Screening Guidance:</u> <u>Technical Background Document</u>. Office of Solid Waste and Emergency Response, EPA/540/R-95/128, May.
- U.S. Environmental Protection Agency (USEPA), 1997. Health Effects Assessment Summary Tables (HEAST), Annual Update: Office of Solid Waste and Emergency Response, EPA 540/R/97/036, PB97-921199.
- U.S. Environmental Protection Agency (USEPA), 1997. <u>Ecological Risk Assessment</u> <u>Guidance for Superfund: Process for Designing and Conducting Ecological Risk</u> <u>Assessment;</u> Interim Final U.S. EPA Document; U.S. EPA Environmental Response Team; Edison, NJ; June 2, 1997.
- U.S. Environmental Protection Agency (USEPA), 1997a. "<u>Exposure Factors Handbook</u>, <u>Volume 1</u>; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.
- U.S. Environmental Protection Agency (USEPA), 1997a. Risk-Based Concentration Table. Prepared by Roy L. Smith, USEPA Region III Technical Program Support Branch. January, 1997
- U.S. Environmental Protection Agency (USEPA), 1997b. "Integrated Risk Information System (IRIS); On-Line Service. January 1997.
- U.S. Environmental Protection Agency, 1997c. <u>Ecological Risk Assessment Guidance</u> <u>for Superfund: Process for Designing and Conducting Ecological Risk</u> <u>Assessment;</u> Interim Final U.S. EPA Document; U.S. EPA Environmental Response Team; Edison, NJ; June 2, 1997.
- U.S. Environmental Protection Agency (USEPA), 1998. Drinking Water Regulations and Health Advisories. Office of Water. EPA822-B-96-002. May.
- U.S. Environmental Protection Agency (USEPA), 1998. USEPA Region III Risk-Based Concentration Table. September.
- U.S. Environmental Protection Agency (USEPA), 1998. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance (External Review Draft). May.
- U.S. Environmental Protection Agency (USEPA), 1999. "Integrated Risk Information System (IRIS)"; on-line data-base search; February.

Harding Lawson Associates

- U.S. Fish and Wildlife Service (USFWS), 1992. "Survey and Evaluation of Wetlands and Wildlife Habitat, Fort Devens, Massachusetts. House of Representatives Appropriations Committee. p. 1 - 10.
- Vanasse Hangen Brustlin, Inc., 1994. Devens Reuse Plan. Prepared for the Boards of Selectmen of the Towns of Ayer, Harvard, Lancaster, and Shirley and the Massachusetts Government Land Bank. November 14, 1994.
- Walton, W.C., 1988. "Practical Aspects of Groundwater Modeling". 3rd Edition. NWWA, 587 p.
- Weiner, J., USFWS, Lacrosse, Wisconsin, 1993. "BAFs for Inorganic Analytes in Freshwater Systems, Plants, and Animals"; Personal communication with Cornell Rosiu of ABB-ES; May.
- Wentsel, R.S., T.W. La Point, M. Simini, R.T. Checkai, D. Ludwig, and L.W. Brewer, 1996. <u>Tri-Service Procedural Guidelines for Ecological Risk Assessments</u>, <u>Volumes I and II</u>; written for the Air Force Center for Environmental Excellence (AFCEE), the Army Environmental Center (AEC), and the Naval Facilities Engineering Service Center (NFESC); June, 1996.
- Weston, Roy F., Inc. 1998. "Contaminated Soil Removal Phase II, Study Area 57, Area 1, Storm Drain System No. 6 Outfall, Removal Action Report". July 1998.
- Wones, D.R. and R. Goldsmith, 1991. Intrusive Rocks of Eastern Massachusetts. U.S. Geological Survey Professional Paper 1366-I.
- Zen, E-an, Ed., 1983. "Bedrock Geologic Map of New England." U.S. Geological Survey; Scale 1:250,000; three sheets.

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TABLE 3-1 USAEC DATA FLAGS AND QUALIFIERS AOC 57

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m = High duplicate spike not within control limits n = Tentatively-identified compound (TIC) by GC/MC with a match greater than 70 %
n = Tentatively-identified compound (TIC) by GC/MC with a match greater than 70 %
p = Value is less than the method reporting limit but greater than the instrument detection limit
q = Confirmatory analysis was performed, however sample interferences prevented confirmation
r = Non-target analyte analyzed for but not detected by GC/MS. Laboratory is not certified for this analyte by the given method
Analyte was not performance demonstrated or validated
s = Non-target compound analyzed for and detected by GC/MS. Laboratory is not certified for this analyte by the given method.
Analyte was not performance demonstrated or validated
t = Non-target compound analyzed for and not detected (non-GC/MS method).
u = Analysis is unconfirmed. Confirmatory analysis was run but did not verify original result
v = Sample was not correctly preserved (i.e. > 4 degrees C or improperly preserved)
a second second and have a second detected by a second of the second s
z = inon-target analyte analyte and detected by non-GC/MS method



REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Federal Standards and Guidance							
	Safe Drinking Wa	ter Act (SDWA) ^(a)	Ambient	Clean Water Act (CWA) Ambient Water Ouality Criteria (AWOC) ^(b)				
			For Pr of Huma	otection in Health	For Protection of Aquatic Life	tanan ang ang ang ang ang ang ang ang ang		
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (μg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)			
Volatile Organics								
acetone	-	-	_	-	-/-	3,700N		
benzene	5	zero	0.66	40	5,300/- ²	0.36C		
carbon tetrachloride	5	zero	0.4	6.94	35,200/- ²	0.16C		
chloroform (THM)	100/80 ³	zero	0.19	15.7	28,900/1,240 ²	0.15C		
ethylbenzene	700	700	1,400	3,280	32,000/-2	1,300N		
styrene	100	100	-	-	-/-	1,600N		
1,1,2,2-tetrachloroethane	-	-	0.17	10.7	-/2,400 ²	0.052C		
tetrachloroethylene	5	zero	0.8	8.85	5,280/840 ²	1.10C		
toluene	1,000	1,000	14,300	424,000	17,500/- ²	750N		
1,1,1-trichloroethane	200	200	18,400	1,030,000	-/-	1,300N		
trichloroethylene	5	zero	2.7	80.7	45,000/21.900 ²	1.6C		
trichlorofluoromethane	-	-	-	-	-/-	1,300N		
xylenes (total)	10,000	10,000	-	-	-/-	12,000N		
Semivolatile Organics								
acenaphthene	-	-	-	-	-/-	-		

.

continued



TABLE 4-1 FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER AOC 57

	Federal Standards and Guidance					
	Safe Drinking Wa	iter Act (SDWA) ^(a)	Ambient	TBC Region III Tap Water (µg/L)		
			For Pr of Hum:	otection in Health	For Protection of Aquatic Life	N C 4
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/I)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
anthracene	_		-	-	-/-	11,000N
bis(2-ethylhexyl)phthalate	6	zero	-	-	-/-	4.80C
benzo(a)anthracene	-	-	-	-	-/-	0.092C
benzo(a)pyrene	2	zero	-	-	-/- ·	0.092C
benzo(b)fluoranthene	_	-	-	-	-/-	0.092C
benzo(g,h,i)perylene	_	_	_	-	-/-	-
benzo(k)fluoranthene	-	-	-	-	-/-	0.092C
benzyl alcohol	-	-	-	-	-	11,000N
carbazole	-	-	-	-	-/-	3.4C
chrysene	-	-	-	-	-/-	9.2C
dibenzofuran	-	-	-	-	-/-	150N
di-n-butyl phthalate	-	-	-		-	3,700N
fluoranthene	-		-	-	_/_	1,500N
fluorene	-	-	-	-	-/-	1,500N

continued



	Federal Standards and Guidance							
	Safe Drinking Wa	iter Act (SDWA) ^(a)	Ambient	TBC Region III Tap Water (μg/L)				
			For Pr of Hum	otection 11 Health	For Protection of Aquatic Life			
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)			
indeno(1,2,3-c,d)pyrene	-	- 	-	-	-/-	0.092C		
2-methylnaphthalene	-	-	-	-	-/-	-		
naphthalene	-	-	-	-	2,300/620 ²	1,500N		
n-nitrosodiphenylamine	-	-	4.9	16.1	-/-	14C		
phenanthrene	-	-	-	-	30/6.3 ⁵	-		
pyrene	-	<u>-</u>	-	-	-/-	1,100N		
Inorganics								
aluminum	-	50 to 200 ⁸			-/-	37,000N		
antimony	6	6 ⁵	146	45,000	88/30 ⁵	15N		
arsenic	50 ¹	-	0.0022	0.0175	360/190 ^{2,7}	11N/0.038C		
barium	2,000	2,000	1,000		-/-	2,600		
beryllium	4 ⁴	4	0.0037	0.0641	130/5.3 ²	0.016C		
cadmium	5	5	10	-	3.9/1.14	18N		
calcium	-	-			-/-	-		

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Federal Standards and Guidance						
	Safe Drinking Water Act (SDWA) ^(a)		Ambient	Clean Water Act (CWA) Ambient Water Ouality Criteria (AWOC) ^(b)			
			For Pr of Hum:	otection on Health	For Protection of Aquatic Life	n an	
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/l)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)		
chromium (total)	100	100	. 	-	1,700/210 ^{4,9}	180	
cobalt	-		-	-	-/-	220	
copper	TT ¹⁰	1,300	-	-	18/12 ⁴	1,400N	
iron	-	300 ⁸	300	-	-/1,000	-	
lead	TT ¹¹	zero	50	_	83/3.2 ⁴	-	
magnesium	-	-	-	-	-/-	-	
manganese		50 ⁸	50	100	-/-	1,800N	
mercury	2	2	0.144	0.146	2.4/0.012	11N	
nickel	100 ⁵	100 ⁵	13.4	100	1,400/160 ⁴	730N	
potassium	-		-	-	-/-	-	
selenium	50	50	10	-	20/5	180N	
silver	-	100 ⁸	50	-	4.1/0.12 ^{4,6}	180N	
sodium	-		-		-/-	_	
vanadium	-					260N	

continued



		Federal Standards and Guidance								
	Safe Drinking Wa	iter Act (SDWA) ^(a)	Ambient	.) (AWQC) ^(b)	TBC Region III Tap Water (µg/L)					
			For Pr of Hum	otection In Health	For Protection					
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/I)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)					
zinc	-	5,000 ⁸			12/110 ⁴	11,000N				
Pesticide/PCBs										
DDT	-		.000024	.000024	1.1/0.001	0.2C				
DDD	-	-	-	-	-/-	0.28C				
DDE	-	-	-	-	1,050/-2	0.2C				
endrin	2	2	1.0	-	0.18/.0023	11N				
alpha chlordane	2 ¹³	zero ¹³	0.00046 ¹³	0.00048 ¹³	2.4/0.0043 ¹³	0.052 ¹³				
gamma chlordane	2 ¹³	zero ¹³	0.00046 ¹³	0.00048 ¹³	2.4/0.0043 ¹³	0.052C ¹³				
heptachlor	0.4	zero	0.00028	0.00029	0.52/.0038	0.0023C				
PCB 1248	0.5 ¹⁴	zero ¹⁴	0.000079 ¹⁴	0.000079 ¹⁴	2.0/0.01414	0.0087C				
PCB 1254	0.5 ¹⁴	zero ¹⁴	0.000079 ¹⁴	0.000079 ¹⁴	2.0/0.01414	0.73C ¹⁴				
PCB 1260	0.5 ¹⁴	zero ¹⁴	0.000079 ¹⁴	0.000079 ¹⁴	2.0/0.01414	0.0087C ¹⁴				

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Federal Standards and Guidance							
	Safe Drinking Wa	iter Act (SDWA) ^(a)	Ambient	TBC Region III Tap Water (µg/L)				
				otection in Health	For Protection of Aquatic Life			
Analyte	ARAR Drinking Water MCL (µg/L)	TBC Drinking Water MCLG (µg/L)	ARAR Water and Fish Consumption (µg/I)	ARAR Fish Consumption Only (µg/L)	ARAR Fresh Water Acute/Chronic (µg/L)			
Explosives								
cycloetramethylenetetranitramine	_	-	-	-	-			
(HMX)								
cyclonite (RDX)	-	-	-	-	-			
2,4-dinitrotoluene	-	-	-	-	-	73N		
2,6-dinitrotoluene	-	-		-	-	37N		
nitroglycerine	-	-	_	_	-	-		
2,4,6-trinitrotoluene	-	-	-	-	-	2.2C		
Cations/Anions		·						
chloride		250,000 ⁸	-	-	860K/230K	-		
phosphate	-	-	-		_/-	-		
sulfate	-	500,000 ¹⁵ /250,000 ⁸		_	-/-			
alkalinity	-	-	-	-	-/20,000	-		

continued

TABLE 4-1 FEDERAL ARARS AND TBC GUIDANCE - GROUNDWATER AND SURFACE WATER AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			de la statist	Federal Standard	s and Guida	ance		
	Safe Drinking Water Act (SDWA) ^(a)			Clean Water Act (CWA) It Water Quality Criteria (AWQC) [®]			TBC Region III Tap Water (µg/L)	
Analyte				For P of Hun	For Protection			
		ARAR Drinking Water MCL (µg/L)	TBC Drinking W MCLG (µ	BC ARAR ng Water Water and Fish Fish (G (µg/L) Consumption (µg/l) Or		RAR onsumption y (μg/L)	ARAR Fresh Water Acute/Chronic (µg/L)	
Othe	*							
nitrat	e/nitrite as N	10,000/1,000 ¹²	Aur	- 10,000/-				58,000N/3,100N
ТРН		_		_				-
(a) (b)	USEPA, "Drinking Water Standards USEPA, "Water Quality Criteria Sun Washington, D.C.; May 1, 1001; or	and Health Advisories", Office of Wannary", Office of Science and Techn	ater, Washington, D. ology, Health and Ec	C.; May 1995. cological Criteria Division,	12 N 13 V	litrate or nitrite as ni alues reported for cl	trogen; standard total nitrate a hlordane (CAS #57-74-9).	nd nitrite is 10,000 µg/l.
CWA ug/L	= Clean Water Act = micrograms per liter	TT	= T	reatment technique required.	14 V 15 P	roposed criteria.	uai FCDS (CAS #1550-50-5).	
MCL MCLG = 1	 Maximum Contaminant I Maximum Contaminant Level Goal MCL for arsenic currently under revi 	Level - N ew. C	= N = N = C	o federal or state guidance criteria or stand oncarcinogenic effects arcinogenic effects	lards exist.			
2 3 4	Insufficient data to develop criteria. 1994 Proposed rule for Disinfectants Hardness dependent criteria (100 mg	Value presented is the Lowest Observ and Disinfection By-Products: Total /L CaCO3 used).	ved Effect Level (LO for all THMs combi	EL). ned would not exceed the 80 ug/L level.				
5 6 7	Standard is being remanded. Proposed level, freshwater acute - 0.9 Values presented are for trivalent spe)2 μg/Ll. cies.						
8 9	Non-enforceable secondary regulatio Values presented are for hexavalent of Transforment table are for hexavalent to	n based on aesthetics (e.g., color, odd chromium species.	er, taste).					
10	Treatment technique action level 1,3	ug/l; concentration measured at top.						

continued

SAMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57B	lower - bottom	08-26-94	2	12,168	1.79 Aroclor 1260
SBSA57W	lower - SW sidewall	08-26-94	0.9	46,876	
SBSA57W1	lower - NE sidewall	08-29-94	0.5	547	
SBSA57W2	lower - SE sidewall	08-29-94	0.8	181	• • • • • • • • • • • • • • • • • • •
SBSA57W3	lower - SE sidewall	08-29-94	0.7	634	
SBSA57W4	lower - SE sidewall	08-29-94	0.4	277	
SBSA57W5	lower - SE sidewall	08-29-94	0.1	139	
SBSA57W6	lower - SE sidewall	08-29-94	0.5	746	
SBSA57W7	lower - SW sidewall	08-29-94	0.1	945	
SBSA57W8	lower - SW sidewall	08-29-94	0.2	19,049	
SBSA57W9	lower - SW sidewall	08-29-94	0.7	31,816	0.64 Aroclor 1260
SBSA57W10	lower - NE sidewall	08-29-94	0.7	987	· · · · · · · · · · · · · · · · · · ·
SBSA57W11	lower - NE sidewall	08-29-94	1.5	46,658	0.60 Aroclor 1260
SBSA57B1	lower - bottom	08-29-94	1.5	5,356	
SBSA57B2	lower - bottom	08-29-94	1.8	7,020	
SBSA57B3	lower - bottom	08-29-94	2.1	1,739	
SBSA57B4	lower - bottom	08-29-94	2.2	12,348	ND Aroclor 1260
SBSA57B5	lower - bottom	08-29-94	1.7	17,635	
SBSA57B6	lower - bottom	08-29-94	1.8	33,764	
SBSA57B7	lower - bottom	08-29-94	2	33,806	0.92 Aroclor 1260
SBSA57B8	lower - bottom	08-29-94	2.1	25,935	
SBSA57JB	middle - SW sidewall	08-29-94	NA	173,974	excavator bucket
SBSA57T2B	upper - SW trench	08-30-94	3	ND	
SBSA57T2A	upper - SW trench	08-30-94	2.9	1,429	
SBSA57T1B	upper - NE trench	08-30-94	2.5	ND	

SAMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T1A	upper - NE trench	08-30-94	3	5,272	
SBSA57T1	lower - SE trench	09-01-94	2.5	2,289	
SBSA57T2	lower - SE trench	09-01-94	2.5	2,494	
SBSA57T3	lower - SE trench	09-01-94	2.5	74,208	
SBSA57T4	lower - SE trench	09-01-94	2.5	62,010	
SBSA57T5	lower - SE trench	09-01-94	2	10,237	
SBSA57T6	lower - SE trench	09-01-94	2.5	119	
SBSA57TP1	lower - NE test pit	09-01-94	NA	50,119	excavator bucket
SBSA57B30	middle - bottom	09-02-94	2.5	3,508	0.21 Aroclor 1260
SBSA57W30	middle - NE sidewall	09-02-94	2	2,604	•
SBSA57W31	middle - NE sidewall	09-02-94	2	ND	
SBSA57W32	middle - NE sidewall	09-02-94	2	7,588	
SBSA57W34	middle - SW sidewall	09-02-94	2	969	
SBSA57T3B1	lower - SE test pit	09-06-94	3.7	ND	
SBSA57T3B2	lower - SE test pit	09-06-94	3.7	65	
SBSA57T3W1	lower - SE test pit	09-06-94	2.7	947	
SBSA57T3W2	lower - SE test pit	09-06-94	2.7	46,546	0.12 Aroclor 1260
SBSA57T3T	lower - SE test pit	09-06-94	NA	1,316	excavator bucket
SBSA57H1B1	lower - SE test pit	09-06-94	2.3	1,331	
SBSA57T4B1	lower - E test pit	09-06-94	3.5	20,418	0.2 Aroclor 1260
SBSA57T4W1	lower - E test pit	09-06-94	2.5	158	
SBSA57T5B1	lower - NE test pit	09-06-94	4	38,746	
SBSA57T5B2	lower - NE test pit	09-06-94	3.5	24,352	

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SĂMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T6B1	lower - NE test pit	09-06-94	3.5	25	
SBSA57T6B2	lower - NE test pit	09-06-94	4	557	
SBSA57T7B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T7W1	lower - SE test pit	09-06-94	NA	1,464	Entire wall scraped
SBSA57T8B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T8W1	lower - SE test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T9B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T9W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T10B1	lower - S test pit	09-06-94	3.5	1,686	
SBSA57T10W1	lower - S test pit	09-06-94	NA	10,491	Entire wall scraped
SBSA57T11B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T11W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T12B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T12W1	lower - S test pit	09-06-94	NA	58	Entire wall scraped
SBSA57T13B1	lower - SW test pit	09-06-94	3.5	3,792	
SBSA57T13W1	lower - SW test pit	09-06-94	NA	1,980	Entire wall scraped
SBSA57T14B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T14W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T15B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T15W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T16B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T16W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T17B1	middle - SW test pit	09-06-94	3.5	ND	
SBSA57T17W1	middle - SW test pit	09-06-94	NA	ND	Entire wall scraped

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SAMPLE D	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W35A	middle - SW sidewall	09-07-94	2.7	23	
SBSA57W36	upper - SW sidewall	09-07-94	1	90	
SBSA57W37	upper - NE sidewall	09-07-94	1	273	
SBSA57W38	upper - SW sidewall	09-07-94	0.5	553	
SBSA57W39	upper - NE sidewall	09-07-94	0.7	23	
SBSA57W40	upper - SW sidewall	09-07-94	1	13	
SBSA57W41	upper - NE sidewall	09-07-94	11	147	· · · · · · · · · · · · · · · · · · ·
SBSA57W42	upper - SW sidewall	09-07-94	0.7	313	
SBSA57W43	middle - NE sidewall	09-07-94	1.8	3,914	• • • • • • • • • • • • • • • • • • •
SBSA57W44	middle - SW sidewall	09-07-94	1	3,843	
SBSA57W45	middle - NE sidewall	09-07-94	2.1	1,042	
SBSA57W46	middle - NE sidewall	09-07-94	2.3	4,464	
SBSA57W47	middle - NE sidewall	09-07-94	2.1	509	
SBSA57B31	middle - bottom	09-07-94	3.5	14,800	
SBSA57B32	upper - bottom	09-07-94	1	55	
SBSA57B33	upper - bottom	09-07-94	1	14	
SBSA57B34	upper - bottom	09-07-94	1	34	
SBSA57B35	middle - bottom	09-07-94	1.3	142	
SBSA57B36	middle - bottom	09-07-94	1.3	2,109	
SBSA57B37	middle - bottom	09-08-94	4	8,264	
SBSA57B38	middle - bottom	09-08-94	3.8	483	
SBSA57B39	middle - bottom	09-08-94	3.7	ND	
SBSA57W48	middle - NE sidewall	09-08-94	2.4	9	
SBSA57W51	middle - NE sidewall	09-08-94	3.5	1,436	

SAMPLE D	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W52	middle - NE sidewall	09-08-94	2.8	813	
SBSA57W53	middle - NE sidewall	09-08-94	• 3.7	8	
SBSA57B41	middle - bottom	09-09-94	4.5	874	
SBSA57B42	middle - bottom	09-09-94	3	564	
SBSA57B43	middle - bottom	09-09-94	2.5	840	
SBSA57B44	middle - bottom	09-09-94	1.5	45	
SBSA57B45	middle - bottom	09-09-94	6	ND	
SBSA57W54	middle - SW sidewall	09-09-94	2.5	984	
SBSA57W55	middle - SW sidewall	09-09-94	3	336	
SBSA57W56	middle - SW sidewall	09-09-94	2.5	17	
SBSA57W57	middle - SW sidewall	09-09-94	3	503	
SBSA57W58	middle - SW sidewall	09-09-94	2.5	710	
SBSA57W59	upper - SW sidewall	09-09-94	2	1,427	
SBSA57W60	upper - SW sidewall	09-09-94	2.3	775	
SBSA57W61	upper - NE sidewall	09-09-94	1	ND	
SBSA57W62	upper - SW sidewall	09-09-94	1.3	206	
SBSA57W63	upper - SW sidewall	09-09-94	1	77	
SBSA57W64	upper - NE sidewall	09-09-94	1.5	1,298	
SBSA57W65	middle - NE sidewall	09-09-94	4	848	
SBSA57W66	middle - NE sidewall	09-09-94	5	7	
SBSA57W67	middle - NE sidewall	09-09-94	4	206	
SBSA57W68	middle - NE sidewall	09-09-94	5	ND	
SBSA57W69	middle - NE sidewall	09-09-94	4	ND	
SBSA57W70	middle - NE sidewall	09-09-94	5	ND	

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	SAMPLE LOCATION ¹ GENERAL -	SAMPLE	SAMPLE DEPTH	TPH RESULT	
SAMPLE ID	SPECIFIC	DATE	(FT)	(µg/g)	COMMENTS
SBSA57TP1B	middle- bottom test pit	09-09-94	7.5	9,671	
SBSA57TP1W1	middle- bottom test pit	09-09-94	5.5	539	
SBSA57TP1W2	middle- bottom test pit	09-09-94	6.5	13,353	·····
SBSA57TP2B	middle- bottom test pit	09-09-94	6	2,227	
SBSA57TP2W1	middle- bottom test pit	09-09-94	4	ND	
SBSA57TP2W2	middle- bottom test pit	09-09-94	5	ND	
SBSA57TP3B	upper- bottom test pit	09-09-94	5	9,223	
SBSA57TP3W1	upper- bottom test pit	09-09-94	3	5,959	
SBSA57TP3W2	upper- bottom test pit	09-09-94	4	13,119	
SBSA57TP4B	upper- bottom test pit	09-09-94	5.5	549	
SBSA57TP4W1	upper- bottom test pit	09-09-94	3.5	ND	
SBSA57TP4W2	upper- bottom test pit	09-09-94	4.5	ND	
SBSA57TP5B	middle- bottom test pit	09-09-94	9	5,521	
SBSA57TP5W1	middle- bottom test pit	09-09-94	8	9,682	
SBSA57TP5W2	middle- bottom test pit	09-09-94	7	13,908	

NOTES:

¹ Sample location is subdivided into general and specific location - "general" refers to which part of Area 2 (lower is closer to wetland); "specific" refers to whether it was a bottom, sidewall, or testpit sample - refer to Figures 5-3 and 5-4.

ND - Indicates non-detect

NA – Not applicable

Note - Depths are approximate

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sample ID	SBSA571	SBSA572	SBSA573	LSSA571	LSSA5702	SBSA57CH1
Date Collected	08-29-94	08-29-94	08-29-94	08-31-94	09-01-94	09-01-94
Matrix	Soil	Soil	Soil	Oil	Oil	Soil
Fuel ID	N/A	N/A	N/A	30% Kerosene	N/A	Kerosene
				70%Lube Oil		Light Lube Oil
<u>TPH¹ (mg/kg)</u>						
light range	1050	624	716	N/A	4000	1380
medium range	3610	3140	2270	N/A	86800	4090
heavy range	36000	35100	26300	N/A	663000	44600
<u>Metals (mg/kg)</u>						
Aluminum	5200	2900	3640	N/A	410	5170
Arsenic	7.8	9.3	7.3	N/A	ND	8.3
Barium	183	37.1	35.8	N/A	53.6	81.1
Cadmium	5.4	ND	ND	N/A	ND	2.5
Calcium	908	322	301	N/A	ND	1010
Chromium	19.7	23.4	19	N/A	12.2	12.8
Copper	53.6	13.2	12.8	N/A	14.4	39.4
Iron	5130	2710	3640	N/A	37.8	4330
Lead	464	199	137	N/A	64.5	306
Magnesium	704	457	734	N/A	ND	536
Manganese	52.6	23.7	32.1	N/A.	ND	69.4
Nickel	7.7	5	5.8	N/A	ND	6.6
Potassium	197	155	198	N/A	ND	146
Vanadium	8	ND	6.5	N/A	ND	5.9
Zinc	438	33	41.3	N/A	5.1	139

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sample ID	SBSA571	SBSA572	SBSA573	LSSA571	LSSA5702	SBSA57CH1
Date Collected	08-29-94	08-29-94	08-29-94	08-31-94	09-01-94	09-01-94
Matrix	Soil	Soil	Soil	Oil	Oil	Soil
Volatiles (mg/kg)						
Ethylbenzene	9.4	ND	ND	N/A	ND	ND
Toluene	12.9	ND	ND	N/A	ND	6.53
Xylenes	63.8	11.6	5.3	N/A	13	25.4
PCBs (mg/kg)						
Aroclor 1242	N/A	N/A	N/A	N/A	29.7	5.8
Aroclor 1254	N/A	N/A	N/A	N/A	28.4	ND
Aroclor 1260	N/A	N/A	N/A	N/A	81.9	4.6

NOTES:

¹ TPH was determined by GC analysis not IR mg/kg = milligrams per kilogram N/A = not applicable ND = compound not detected

TABLE 5-6 AREA 1 SOIL REMOVAL ANALYTICAL RESULTS ABOVE REGULATORY LEVELS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sample	Compound	Concentration	MCP S-1/GW-1
AOC57-A1-SW1	РАНя	2012 (HB/B)	Кедшашту Естег (рд/д)
	Benzo(a)anthracene	2.36	<u>0.7</u>
	Benzo(b)fluoranthene	4.4	0.7
	Benzo(a)pyrene	2.11	0.7
	Indeno(1,2,3-cd)pyrene	1.75	0.7
AOC57-A1-SW2	EPH	的复数形式影响的影响	
	C ₁₀ -C ₂₂ Aromatics	532	200
	PAHs		de la contra de la c
	Benzo(a)anthracene	7.53	0.7
	Benzo(a)pyrene	8.15	0.7
	Chrysene	10.7	7
	Dibenzo(a,h)anthracene	2.47	0.7
	Indeno(1,2,3-cd)pyrene	6.0	0.7
AOC57-A1-SW4	PAHs	<u>影響 等時時</u> 建陸陸陸陸	
	Benzo(a)anthracene	3.07	0.7
	Benzo(b)fluoranthene	6.69	0.7
	Benzo(a)pyrene	3.44	0.7
	Dibenzo(a,h)anthracene	1.13	0.7
	Indeno(1,2,3-cd)pyrene	3.02	0.7
AOC57-A1-SW1/B	PAHs		
	Benzo(a)anthracene	2.0	0.7
	Benzo(b)fluoranthene	2.8	0.7
	Benzo(a)pyrene	2.4	0.7
	Indeno(1,2,3-cd)pyrene	1.8	0.7
AOC57-A1-SW4/B	PAHs	机 机酸盐 机酸盐 的复数	
	Benzo(a)anthracene	5.1	0.7
	Benzo(a)pyrene	6.1	0.7
	Benzo(b)fluoranthene	6.1	0.7
	Indeno(1,2,3-cd)pyrene	4.7	0.7

Notes:

 $(\mu g/g) = Micrograms Per$

MCP = Massachusetts Contingency Plan

PAHs = polyaromatic hydrocarbons

EPH = extractable petroleum hydrocarbons

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T	5-7						
SUMMARY	OF TEST PITS						
AOC 57							

EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	ANALYTICAL SAMPLÆS COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
REMEDIAL INVESTIGATION						
57E-95-01X	9	0-1 1-2 5-6 8-9	F F F,O,G O	BKG	SW (0-1.5) SP(1.5-9)	D BROWN SILTY- SAND(2"-6") LENS
57E-95-02X	10	0.50 5.00 10.00	F,O F,O,G O	BKG BKG BKG	SW(0-2) SW(2-10)	ASH LAYER
57E-95-03X	10	1.00 2.00 5.00 10.00	0 0 F,O,G 0	BKG	SW(0-2) SP(2-10)	4-6" BLACK LENS
57E-95-04X	12	1.00 5.00 12.00	F F,O F	BKG BKG - BKG	SP-SM(0-2) SP (2-12)	
57E-95-05X	13	1.00 6.00 13.00	F F,O,G F	BKG BKG BKG	SM(1-1.5) SP (1.5-13)	
57E-95-06X	11	1.00 6.00 11.00	F,O,G F,O,G F	BKG BKG BKG	SM(0-1) SM (1-3) SP (3-11)	ASH LAYER
57E-95-07X	7	1.00 4.00 7.00	F F,O F	BKG 140 53	SM(0-3) SM (3-4) SP(4-7)	FUEL ODOR 4-7' GW 7 FEET BGS
57E-95-08X	6	1.00 4.00 6.00	F F,O,G F	BKG BKG BKG	SM (0-5) SM SP(5-6)	DEBRIS,SEPTIC ODOR GW 6 Feet bgs
57E-95-09X	8	1.00 5.00 8.00	F F,O F	BKG BKG BKG	SW(0-1) SW(1-4) SP (5-8)	BLACK ORGANIC(4-5) STRONG SEPTIC ODOR
57E-95-10X	10	0.00 6.00 10.00	0-1 F,O F,O F	BKG BKG BKG	(0-2) SM(2-5) SM5-10)	
57E-95-11X	13	0-1 5-6 12-13	F F,O F	BKG BKG BKG	SM (0-2) SM (2-13)	

Т.	5-7
SUMMARY	OF TEST PITS
AO	C 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	ANALYTICAL SAMPLES COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
57E-95-12X	13	0-1	F,O,G	BKG	SM(0-3)	1
		3-4	F,O,G	1.4	BLACK ORGANIC(3-6)	STRONG FUEL ODOR
		12-13	F	BKG	SP (6-13)	GW 8 FEET BGS
57E-95-13X	11	0-1	F	0.03	('0-2)	
		4-5	F,O	BKG	SP(3-11)	
		10-11	F	BKG		
57E-95-14X	6	0-1	F	BKG	SP (0-1)	
		1-2	F	BKG	BLACK ORGANIC (6" Thick)	SEPTIC ODOR
		5-6	F,O	BKG	SP (2-6)	GW 6 FEET BGS
57E-95-15X	5	0-1	F	BKG	SM (0-1)	
		1-2	F,O,G	12	BLACK ORGANIC LAYER(1.5-2)	FUEL ODOR
		4-5	F	3.2	SP (2-5)	
57E-95-16X	5	0-1	F,O	BKG	SM (0-1)	
		2-3	F,O,G	7.8	BLACK ORGANIC (1-2)	FUEL ODOR
		4-5	F	3.2	SP (2-5)	FUEL ODOR, GW 5 FEET BGS
57E-95-17X	5	0-1	F,O,G	BKG	SM (0-2)	
		2-3	F,O	21.5		STRONG FUEL ODOR
		4-5	F	93	SP(2-5)	STRONG FUEL ODOR
57E-95-18X	3	0-1	F	BKG	BLACK ORGANIC (0-1)	
		1-2	F,O,G	BKG	SP (1-2)	
		2.5-3	F	BKG	SP (2-3)	
57E-95-19X	3.5	0-1	F	BKG	SM (0-1.5)	
		1-2	F,O	BKG	BLACK ORGANIC (1.5-2)	
		2-3	F	BKG	SP (2-3.5)	GW 3.5 FEET BGS
57E-95-20X	6	0-1	F	BKG	SP (0-1)	
		2-3	F	BKG	SW (1-3)	
		4-5	F,0	BKG	SP (3-5)	GW 6 FEET BGS
57E-95-21X	10	0-1	F	BKG	SM (0-1)	DEBRIS, ASHES
		2-3	F	BKG	SP(1-3)	DEBRIS, TRACE SILT
		5-6	F	BKG	DEBRIS (3-6)	ASH, D BWN LENS (4-5)
		9-10	F	BKG	SM(5-10)	
57E-95-22X	10	0-1	F	BKG	SAMPLE BENEATH DRUM	
		3-4	F	BKG	SM DEBRIS, ASH (0-5)	
		9-10	F	BKG	SP (5-10)	NO GW ENCOUNTERED
57E-95-23X	10	0-1	F	BKG	SM DEBRIS (0-5)	
		3-4	F	BKG		
		9-10	F	BKG	SP (5-10)	NO GW ENCOUNTERED

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.

T. 5-7 SUMMARY OF TEST PITS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			ANALYTICAL			
EXPLORATION	COMPLETION DEPTH	SAMPLE INTERVALS	SAMPLES	TOTAL VOCS	SOIL TYPE	COMMENTS
ID	(FEET bgs)	(FEET bgs)	COLLECTED	BY PID (PPM)	(USCS)	
57E-95-24X	10	0-1	F	BKG	VEGETATION, TOPSOIL (0-0.5)	VEHICLE TRANSMISSION
		3-4	F	19	SM, COAL (0-4)	OILY ODOR
		6-7	F	48	SM (4-7)	GASOLINE ODOR
		9-10	F	29	SM	GASOLINE ODOR
57E-95-25X	12	0-1	F	BKG	SM (0-1)	
		1-2	F	BKG	SW(1-2)	PIECES OF PAVEMENT
		11-12	F	BKG	SP	
57E-95-26X	11	0-1	F	BKG	SM (0-1)	COAL/ASH 1-2 INCHES BGS
		2-3	F,O	BKG	SM (1-3)	
		10-11	F	BKG	SP (3-11)	
57E-95-27X	12	0-1	F	BKG	SM (0-1)	BLK COAL ASH 3 INCHES BGS
		1-1.5	F	BKG	SM (1-1.5)	
		11-12	F,O	BKG	SP (1.5-12)	NO GW ENCOUNTERED
REMEDIAL INVESTIGATION	MOD 001					
57E-96-28X	10	0-3	F	BKG	SM (0-2.5)	
		5-6	F	146		
		9-10	F,O	105		
		7-8	F	BKG	SW-SM DEBRIS (2.5-5)	
		8-9	F	BKG	SP (5-10)	
57E-96-29X	11	1-2	PID ONLY	BKG	L TAN SM (0-2)	TOP SOIL
		4-5	F	0.8	SW (2-4.5)	DEBRIS-FILL
		9-10	F	3	SP	SEPTIC ODOR
		3-4	F	BKG	(4.5-11)	
		4-4.5	PID ONLY	BKG		SAW DUST LAYER
		6-7	F	BKG		
		10-11	F	0.4		
57E-96-30X	10-11	1-2	F	BKG	SM TOP SOIL (0-1)	
		3-4	F	4.1	SM (1-4)	
		5-6	F,O	18.2	SW(4-6)	DEBRIS
		8-9	F	22		
		4.5-5	F	54		
		7-8	PID ONLY	120	SP (6-11)	
		10.5-11	F	12		
		4-5	F	BKG		
1		8-9	F	4		

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			ANALYTICAL			
EXPLORATION ID	COMPLETION DEPTH (FEET bgs)	SAMPLE INTERVALS (FEET bgs)	SAMPLES COLLECTED	TOTAL VOCS BY PID (PPM)	SOIL TYPE (USCS)	COMMENTS
57E-96-31X	10	3-4	F	102	SM TOP SOIL (0-2)	
		8-9	F	30	SW-SM FILL (2-4)	DEBRIS
		5-6	F,O	4	SM STAINED (4-5)	
		9-10	F	152	SM(5-10)	
1		6-7	F	0.3		
		8-9	F	BKG		

.

NOTES:

BKG = Background

ppm = Parts per million

F = Field screening

O = Offsite screening

G = Grain analysis using Sieve screen

USCS = Unified Soil Classification System

SW = Well graded sand

SP = Poorly graded sand

SM = Silty sand

TABLE 5-8 SUMMARY OF SOIL BORINGS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

an merina and the second			OFF-SITE			
ACCESSED SUBJECT OF	COMPLETION	REFERENCE	ANALYTICAL	SOIL	TOTAL VOCS	essential marketing the second second
EXPLORATION	DEPTH	SAMPLE INTERVALS	SAMPLES	TYPE	BY PID	
D	(Feet bgs)	(Feet bgs)	COLLECTED	(USCS)	(PPM)	COMMENTS
PREVIOUS INVEST	FIGATIONS					
G3M-92-02X	31	0-2		SP	10	VOC readings believed to be due to
		5-7		SP	15	high ambient humidity
		10-12		SP	25	
		15-17		SP	10	
		20-22		SP	8	
		25-27	25-27	SP	0	
G3M-92-07X	32	0-2		SW/SP	<5	
		5-7		SP	0.3	
		10-12		SP	0.2	
		15-17		SP	0.7	
		20-22		SP	0.4	
		25-27	25-27	SP	0.3	
REMEDIAL INVES	TIGATIONS					
57B-95-01X	23	0-2	0-2	SW-SM	0	
		5-7	5-7	SW	0	
		10-12		SW	0	
		15-17		SW	0	
		17-19		SW	0	
		19-21		SP	0	
:		21-23	21-23	SP	0	
57B-95-02X	19	0-2	0-2	SM	0	
		5-7	5-7	SW-SM	0	
		10-12		SW-SM	0	
		15-17		SW-SM	0	
		17-19	17-19	SW-SM	0	
57B-95-03X	24	0-2	0-2	SM	0	
		5-7	5-7	SW-SM	0	
		10-12		SP	0	
		15-17		SW-SM	0	
		17-19		SW-SM	0	
		19-21		SW-SM	NR	
		21-23	21-23	SW-SM	NR	
57B-95-04X	17	0-2		SM	0	
		5-7		SW-SM	0	
		10-12		SW	0	
		15-17	15-17	SP	0	
57B-95-05X	17	0-2		SM	0	
		5-7		SW-SM	0	
		10-12		SW-SM	0	
	1	15-17	15-17	SW-SM	0	
57B-95-06X	16	0-2		SW-SM	0	
		5-7		SM	0	
	1	10-12		SW-SM	0	
1		12-14	12-14	sw	0	
		14-16		SW	0	
57M-95-01X	30	0-2		SM/SW	NR	
		2-4		sw	NR	
		4-6		SP	NR	
		6-8		SP-SW	NR	
		8-10		sw	NR	

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TABLE 5-8 SUMMARY OF SOIL BORINGS AOC 57

CONSIGNATION CONSIGNATION OF THE			OFF-SITE			
	COMPLETING N		LABORATORY	2017	TOTAL	New York Control of the Astronomy State
EXPLOPATION	DEPTH	REFERENCE	ANALYIICAL SAMPLES	SOIL	IUIAL VOUS	server of the server of the server of the server of the
ID	(Feet bgs)	(Feet bys)	COLLECTED	(USCS)	(PPM)	COMMENTS
		10-12		SW/SP	NR	
		12-14		SP	NR	
		14-16		sw	NR	
		16-18		SP	NR	
		18-20		SP	NR	
		20-22		SP	NR	
		22-24	22-24	SP	NR	
		24-26		SP	NR	
		26-28		SP	NR	
		28-30		SP	NR	
57M-95-02X	25	0-2		SM	0	
		5-7		SM	0	
		10-12		SW-SM	0	
		15-17		SW-SM	0	
		17-19		sw	0	
		19-21	19-21	SW	0	
57M-95-03X	18	0-2		SM	0	
		2-4		SM	0	
		4-6		SM	0	
		6-8		SM	0	
		8-10		SW-SM	0	
		10-12	10-12	SM	4.2	
		12-14		SW-SM	2.3	
		14-16		SW-SM	15.4	
		16-18		SW-SM	13.5	
57M-95-04A	13	1.5-3.5		OL/SP	0.2	
57M-95-04B	32	0-2		OL/SP	0.2	
		2-4	2-4	ML/SP	0.2	
		5-7		SP	0.2	
		10-12		SP	0.2	
		15-17		SP	0.2	
		20-22		SP	0.2	
		25-27		SP	0.2	
		30-32		SP	0.2	
57M-95-05X	20	0-2		SM	0	
		5-7		SM/SW	0	
		10-12		SW-SM	0	
		12-14		SW-SM	0.4	
573 (07 0 ())		14-16	14-16	SW-SM	0.4	
57M-95-06X	23	0-2		SM/SP	0.2	
		5-7		SP	0.2	
		10-12	1	SP	0.2	
		15-17		SP	0.2	
6734 05 0734		20-23		SP	0.2	
5/M-95-0/X	14	0-2		SM/ML	8.7	
		2-4		SM	4.9	
		4-0	4-6	SW-SM		
		0-8		SW-SM	4.2	
		8-10		SW-SM	1.1	
		10-12		SW-SM	3.4	
57N 05 00 A	15	12-14		SW-SM	0.3	See hering 57M OF 00D
57191-95-08A	1.5	0-7		011/01/		See Dalua 2 Mar 2
1		7-9	7-9	SW-SM	0	
1	6	9-15	1	1	1	ISee boring 5/M-95-08B

TABLE 5-8 SUMMARY OF SOIL BORINGS AOC 57

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			OFF-SITE			
and second doubt	COMPLETION	REFERENCE	ANALYTICAL	SOIL	TOTAL VOCS	We want the second second second
EXPLORATION	DEPTH	SAMPLE INTERVALS	SAMPLES	TYPE	BY PID	
ID	(Feet bgs)	(Feet bgs)	COLLECTED	(USCS)	(PPM)	COMMENTS
57M-95-08B	30	0-2		SM-ML	0	
		2-4		SM	1.1	
		4-6	4-6	SM	0	
		6-8		SW-SM	0	
		8-10		SW-SM	0	
		10-12		SW-SM	0	
		12-14		SM	0	
		14-16		SM	0	
		16-18		SM	0	
		18-20		SM	0	
		20-22		SM	0	
		22-24		SM	0	
		24-26				No тесоvегу
		26-28		SM	0	
		28-30		SM	0	
57P-95-01A, -01B	17	0-2		SW-SM	0	
		5-7		SW-SM	0	
		. 10-12		SM	0	
		15-17		SW-SM	0	
KEMEDIAL INVES	IIGATION MOD UU	1	~ ~	<u> </u>		
57B-90-07X	12	0-2	0-2	SP	230	
		J-/	3-7	or	300	
578-06-087	10	0.2	<u>^</u>	Sr SW	0.1	
57D-90-00X	12	57	57	5 YY 6 D	0.4	
		10-12	<i>۱-</i> ۲	SM	1	
57B-96-09X	12	0.2	0-2	SM	0	
	12	5.7	5-7	SP		
		10-12	5-1	SP		
57B-96-10X	17	5-7	5-7	SP	0	
		10-12	10-12	SP	0 0	
		15-17		SP	ŏ	
57B-96-11X	17	5-7	5-7	SP	0	
		10-12	10-12	SP	ō	
		15-17		SP	ō	
57B-96-12X	5				64	
57M-96-09X	21	0-2		SM	0	
		4-6		SP-SM	0	
		9-11		SP	0	
		14-16	14-16	SP	0	
		19-21		SP	0	
57M-96-10X	13	5-7	5-7	SM	0	
57M-96-11X	12	5-7	5-7	SM	0.4	
57M-96-12X	12	5-7	5-7	SM	0	
57M-96-13X	12	5-7	5-7	SM	0	
NOTES:					•••	

NR = Not recorded

USCS = Unified Soil Classification System SW = Well graded sand

SP = Poorly graded sand

SM = Silty sand

OL = Organic soils

ppm = Parts per million

TABLE 5-9 MONITORING WELL COMPLETION DETAILS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	SOIL	MEDIA	WELL SCREEN	WELL SCREEN	COMPLETION	
WELL	DRILLING	SCREENED	DEPTH	ELEVATION	DEPTH	CONSTRUCTION
IDENTIFICATION	METHOD	(USCS)	(Feet bgs)	(Feet MSL)	(Feet bgs)	MATERIAL
PREVIOUS INVESTIGATIONS						
G3M-92-02X	HSA	SP	21-31	230.0-220.0	31	4" ID PVC
G3M-92-07X	HSA	SP	22-32	229.9-219.9	32	4" ID PVC
REMEDIAL INVESTIGATION						
57M-95-01X	HSA	SP	19-29	226.7-216.7	29	4" ID PVC
57M-95-02X	HSA	sw	14-24	226.0-216	25	4" ID PVC
57M-95-03X	HSA	SW-SM	7-17	225,5-215.5	18	4" ID PVC
57M-95-04A	HSA	SP	2.4-12.4	220.3-210.3	13	4" ID PVC
57M-95-04B	HSA	SP	18.5-28.5	203.9-193.9	30	4" ID PVC
57M-95-05X	HSA	SW-SM	10-20	224.9-214.9	20	4" ID PVC
57M-95-06X	HSA	SP	11.9-21.9	222.5-212.5	23	4" ID PVC
57M-95-07X	HSA	SW-SM	3-13	220.4-210.4	14	4" ID PVC
57M-95-08A	HSA	SW-SM	3-13	219.7-209.7	15	4" ID PVC
57M-95-08B	HSA	SM	18-28	204.2-194.2	30	4" ID PVC
57P-95-01A	HSA	SW-SM	2-5	220-217	15	1" ID PVC
57P-95-01B	HSA	SM	10-15	212-207	15	1" ID PVC
REMEDIAL INVESTIGATION MO	D 001					
57M-96-09X	HSA	SP	12.8-22.8	227.4-217.4	23	2" ID PVC
57M-96-10X	HSA	SM	3-13	224.1-214.1	13	2" ID PVC
57M-96-11X	HSA	SM	2-12	220.2-210.2	12	2" ID PVC
57M-96-12X	HSA	SM	2-12	222.8-212.8	12	2" ID PVC
57M-96-13X	HSA	SM	2-12	223.1-213.1	12	2" ID PVC
Supplemental Investigation						
57P-98-02X	Hand Auger	SP-SM	0.3-2.3	220.1-218.1	2.3	1" ID PVC
57P-98-03X	Hand Auger	SP	2.5-5.5	218.0-215.0	5.5	1" ID PVC
57P-98-04X	Hand Auger	SP	2-5	218.3-215.3	5	1" ID PVC

MSL = Mean Sea Level

PVC = Polyvinyl Chloride

ID == Inside Diameter

Notes:

NA= Not Applicable

HSA= Boring advanced with hollow stem auger.

USCS = Unified Soil Classification System

SW = Well graded sand

SP = Poorly graded sand

SM = Silty Sand

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TAکست 6-1 SUMMARY OF WATER LEVEL ELEVATION DATA AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			DECEMBER	7, 1995	MARCH	26, 1996	JULY	23, 1996
		ELEV. OF	DEPTH	ELEV. OF	DEPTH	ELEV. OF	DEPTH	ELEV. OF
WELL	REF	REF POINT	TOWATER	WATER	TO WATER	WATER	TO WATER	WATER
m	POINT	(FEET MSL)	(FEET)	(FEET MSL)	(FEET)	(FEET MSL)	(FEET)	(FEET MSL)
G3M-92-02X	PVC	251.00	26.28	224.72	25.50	225,5	24.81	226.19
G3M-92-07X	PVC	251.88	26.93	224.95	26.12	225.76	25.28	226.6
57M-95-01X	PVC	248.19	23.64	224.55	22.86	225.33	22.33	225.86
57M-95-02X	PVC	242.16	18.06	224.1	17.37	224.79	17.09	225.07
57M-95-03X	PVC	234.97	11.12	223.85	9.57	225.4	10.02	224.95
57M-95-04A	PVC	223.83	3.01	220.82	2.72	221.11	2.75	221.08
57M-95-04B	PVC	224.67	3.84	220.83	3.54	221.13	3.58	221.09
57M-95-05X	PVC	237.31	15.34	221.97	14.89	222.42	15.77	221.54
57M-95-06X	PVC	236.56	13.56	223	12.81	223.75	12.72	223.84
57M-95-07X	PVC	224.57	3.35	221.22	3.03	221.54	3.01	221.56
57M-95-08A	PVC	224.11	2.92	221.19	2.64	221.47	2.66	221.45
57M-95-08B	PVC	224.70	3.69	221.01	3.34	221.36	3.35	221.35
57M-96-09X	PVC	242.62	-	-			-	-
57M-96-10X	PVC	229.55	_	_		-	_	-
57M-96-11X	PVC	224.38	-	-	-	-	-	-
57M-96-12X	PVC	227.87	-	-	-		-	-
57M-96-13X	PVC	227.73	-	-	-	-	-	-
57P-95-01A	PVC	223.29	3.79	219.5	2.64	220.65	2.66	220.63
57P-95-01B	PVC	223.10	3.35	219.75	2.17	220.93	2.18	220.92
57P-98-02X	PVC	222.82		-				
57P-98-03X	PVC	222.49	-			_		_
57P-98-04X	PVC	223.06	-	-		_		

NOTES:

ELEV. = Elevation

MSL = Mean Sea Level

PVC = Top of Polyvinyl Chloride well riser

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TALLE 6-1 SUMMARY OF WATER LEVEL ELEVATION DATA AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	JANUARY 15	, 1997	JUNE 2, 1997		SEPTMEB	ER 23, 1998
	DEPTH	ELEV. OF	DEPTH	ELEV.OF	DEPTH	ELEV. OF
WELL	TO WATER	WATER	TO WATER	WATER	TO WATER	WATER
D	(FEET)	(FEET MSL)	(FEET)	(FEET MSL)	(FEET)	(FEET MSL)
G3M-92-02X	24.29	226.71	24.21	226.79	25.26	225.74
G3M-92-07X	24.72	227.16	24.61	227.27	25.72	226.16
57M-95-01X	21.87	226.32	21.87	226.32	22.72	225.47
57M-95-02X	16.76	225.4	16.75	225.41	17.25	224.91
57M-95-03X	10.09	224.88	10.42	224.55	10.66	224.31
57M-95-04A	2.58	221.25	2.58	221.25	2.64	221.19
57M-95-04B	3.40	221.27	3.38	221.29	3.49	221.18
57M-95-05X	14.49	222.82	14.51	222.8	14.77	222.54
57M-95-06X	12.41	224.15	12.52	224.04	13.06	223.5
57M-95-07X	2.81	221.76	2.82	221.75	2.93	221.64
57M-95-08A	2.44	221.67	2.53	221.58	2.46	221.65
57M-95-08B	3.13	221.57	3.15	221.55	3.35	221.35
57M-96-09X	16.65	225.97	16.80	225.82	18.08	224.54
57M-96-10X	6.43	223.12	6.80	222.75	5.91	223.64
57M-96-11X	3.29	221.09	3.37	221.01	3.16	221.22
57M-96-12X	4.39	223.48	4.47	223.4	4.81	223.06
57M-96-13X	4.28	223.45	4.38	223.35	4.62	223.11
57P-95-01A	2.58	220.71	2.59	220.7	2.62	220.67
57P-95-01B	2.04	221.06	2.06	221.04	2.15	220.95
57P-98-02X	-	-	<u> </u>	_	2.61	220.21
57P-98-03X		-		-	2.32	220.17
57P-98-04X	-	-	-	-	2.91	220.15

NOTES:

ELEV. = Elevation

MSL = Mean Sea Le

PVC = Top of Polyv

TABLE 6-2 SUMMARY OF HYDRAULIC CONDUCTIVITY TEST RESULTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		San Station of Sand			5 <u>5</u> 1 1				Bouwer	and Rice	Hvo	rslev	a state of the second
Well ID	Well Diam. (In)	(feet, bgs)	Filter Pack Int. (feet, bgs)	Saturated Height (feet)	Re (feet)	Rw (feet)	Le (feet)	Hw (feet)	Hydraulic Cond. (ft/min)	Hydraulic Cond. (cm/s)	Hydraulic Cond. (ft/min)	Hydraulic Con (ent/s)	d. Screened Geology (USCS)
57M-95-01X	4	19 to 29	13 to 29	7.09	0.29	0.46	7.09	7.09	2.40E-01	1.22E-01	2.49E-02	1.26E-02	SP
57M-95-02X	4	14 to 24	9 to 25	8.81	0.29	0.46	9.81	9.81	1.80E-01	9.14E-02	1.61E-02	8.17E-03	SW-SM
57M-95-03X	4	7 to 17	5 to 18	9.51	0.29	0.46	10.51	10.51	1.10E-02	5.59E-03	1.04E-03	5.27E-04	SW-SM
57M-95-04A	4	2.4 to 12.4	1.9 to 13	10.15	0.29	0.46	10.75	10.75	5.70E-02	2.90E-02	5.70E-03	2.90E-03	SP
57M-95-04B	4	18.5 to 28.5	13 to 30	27.31	0.17	0.46	17	28,81	2.30E-02	1.17E-02	5.77E-03	2.93E-03	SP
57M-95-05X	4	10 to 20	6 to 20	7.09	0.29	0.46	7.09	7.09	1.00E-01	5.08E-02	1.01E-02	5.14E-03	SW-SM
57M-95-06X	4	11.9 to 21.9	8 to 23	11.22	0.29	0.46	12.32	12.32	1.70E-02	8.64E-03	1.66E-03	8.42E-04	SP
57M-95-07X	4	3 to 13	2 to 14	11.37	0.29	0.46	12.37	12.37	6.70E-02	3.40E-02	7.00E-03	3.56E-03	SW-SM
57M-95-08A	4	3 to 13	2 to 15	11.32	0.29	0.46	13	13.32	8.30E-04	4.22E-04	8.42E-05	4.28E-05	SW-SM
57M-95-08B	4	18 to 28	13 to 30	26.64	0.17	0.4G	17	28.64	7.40E-03	3.76E-03	2.02E-03	1.03E-03	SM
57M-96-09X	2	12.8 to 22.8	8 to 23	8.53	0.2	0.33	8.73	8.73	8.15E-03	4.14E-03	4.18E-04	2.13E-04	SP
57M-96-10X	2	3 to 13	2 to 13	9.03	0.2	0.33	9.03	9.03	1.36E-03	6.89E-04	4.39E-05	2.23E-05	SM
57M-96-11X	2	2 to 12	1.5 to 12	10.91	0.2	0.33	10.91	10.91	2.11E-03	1.07E-03	1.28E-04	6.53E-05	SM
57M-96-12X	2	2 to 12	1.5 to 12	10.66	0.2	0.33	10.66	10.66	2.60E-03	1.32E-03	1.20E-04	6.10E-05	SM
57M-96-13X	2	2 to 12	1.5 to 12	10.39	0.2	0.33	10.39	10.39	2.96E-03	1.50E-03	1.62E-04	8.24E-05	SM

Geom. Mean

Average

1.34E-02

4.80E-02

6.79E-03

2.44E-02

1.18E-03

5.02E-03

6.01E-04

2.55E-03

x

Notes:

Hydraulic conductivities for 1996-series wells are the average of results of two rising head tests.

Data analyzed using AQTESOLV (Bouwer & Rice Solution).

Rc = Well casing radius for fully saturated filterpacks and equivalent casing radius which accounts for

filterpack resaturation at n=30% for partially saturated filterpacks.

Rw = Radius of borehole.

Le = Saturated length of filterpack.

Hw = Height of Water Column above filterpack bottom.

Saturated Height is height of water column measured in well.

All measurements in feet unless otherwise noted.

USCS = Unified Soil Classification

SW = Well Graded Sand.

SP = Poorly Graded Sand.

SM = Silty Sand.

SW-SM = Well graded sand with silt

SAMPLE ID	SAMPLE - LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57B	lower - bottom	08-26-94	2	12,168	1.79 Aroclor 1260
SBSA57W	lower - SW sidewall	08-26-94	0.9	46,876	
SBSA57W1	lower - NE sidewall	08-29-94	0.5	547	
SBSA57W2	lower - SE sidewall	08-29-94	0.8	181	
SBSA57W3	lower - SE sidewall	08-29-94	0.7	634	
SBSA57W4	lower - SE sidewall	08-29-94	0.4	277	
SBSA57W5	lower - SE sidewall	08-29-94	0.1	139	
SBSA57W6	lower - SE sidewall	08-29-94	0.5	746	
SBSA57W7	lower - SW sidewall	08-29-94	0.1	945	
SBSA57W8	lower - SW sidewall	08-29-94	0.2	19,049	
SBSA57W9	lower - SW sidewall	08-29-94	0.7	31,816	0.64 Aroclor 1260
SBSA57W10	lower - NE sidewall	08-29-94	0.7	987	
SBSA57W11	lower - NE sidewall	08-29-94	1.5	46,658	0.60 Aroclor 1260
SBSA57B1	lower - bottom	08-29-94	1.5	5,356	
SBSA57B2	lower - bottom	08-29-94	1.8	7,020	
SBSA57B3	lower - bottom	08-29-94	2.1	1,739	
SBSA57B4	lower - bottom	08-29-94	2.2	12,348	ND Aroclor 1260
SBSA57B5	lower - bottom	08-29-94	1.7	17,635	
SBSA57B6	lower - bottom	08-29-94	1.8	33,764	
SBSA57B7	lower - bottom	08-29-94	2	33,806	0.92 Aroclor 1260
SBSA57B8	lower - bottom	08-29-94	2.1	25,935	
SBSA57JB	middle - SW sidewall	08-29-94	NA	173,974	excavator bucket
SBSA57T2B	upper - SW trench	08-30-94	3	ND	
SBSA57T2A	upper - SW trench	08-30-94	2.9	1,429	

SAMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T1B	upper - NE trench	08-30-94	2.5	ND	
SBSA57T1A	upper - NE trench	08-30-94	3	5,272	
SBSA57T1	lower - SE trench	09-01-94	2.5	2,289	······································
SBSA57T2	lower - SE trench	09-01-94	2.5	2,494	
SBSA57T3	lower - SE trench	09-01-94	2.5	74,208	
SBSA57T4	lower - SE trench	09-01-94	2.5	62,010	
SBSA57T5	lower - SE trench	09-01-94	2	10,237	
SBSA57T6	lower - SE trench	09-01-94	2.5	119	
SBSA57TP1	lower - NE test pit	09-01-94	NA	50,119	excavator bucket
SBSA57B30	middle - bottom	09-02-94	2.5	3,508	0.21 Aroclor 1260
SBSA57W30	middle - NE sidewall	09-02-94	2	2,604	
SBSA57W31	middle - NE sidewall	09-02-94	2	ND	-
SBSA57W32	middle - NE sidewall	09-02-94	2	7,588	-
SBSA57W34	middle - SW sidewall	09-02-94	2	969	
SBSA57T3B1	lower - SE test pit	09-06-94	3.7	ND	
SBSA57T3B2	lower - SE test pit	09-06-94	3.7	65	
SBSA57T3W1	lower - SE test pit	09-06-94	2.7	947	
SBSA57T3W2	lower - SE test pit	09-06-94	2.7	46,546	0.12 Aroclor 1260
SBSA57T3T	lower - SE test pit	09-06-94	NA	1,316	excavator bucket
SBSA57H1B1	lower - SE test pit	09-06-94	2.3	1,331	
SB\$A57T4B1	lower - E test pit	09-06-94	3.5	20,418	0.2 Aroclor 1260
SBSA57T4W1	lower - E test pit	09-06-94	2.5	158	
SBSA57T5B1	lower - NE test pit	09-06-94	4	38,746	
SBSA57T5B2	lower - NE test pit	09-06-94	3.5	24,352	

SAMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57T6B1	lower - NE test pit	09-06-94	3.5	25	
SBSA57T6B2	lower - NE test pit	09-06-94	4	557	
SBSA57T7B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T7W1	lower - SE test pit	09-06-94	NA	1,464	Entire wall scraped
SBSA57T8B1	lower - SE test pit	09-06-94	3.5	ND	
SBSA57T8W1	lower - SE test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T9B1	lower - S test pit	09-06-94	3.5	ND	-
SBSA57T9W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T10B1	lower - S test pit	09-06-94	3.5	1,686	
SBSA57T10W1	lower - S test pit	09-06-94	NA	10,491	Entire wall scraped
SBSA57T11B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T11W1	lower - S test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T12B1	lower - S test pit	09-06-94	3.5	ND	
SBSA57T12W1	lower - S test pit	09-06-94	NA	58	Entire wall scraped
SBSA57T13B1	lower - SW test pit	09-06-94	3.5	3,792	
SBSA57T13W1	lower - SW test pit	09-06-94	NA	1,980	Entire wall scraped
SBSA57T14B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T14W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T15B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T15W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T16B1	lower - SW test pit	09-06-94	3.5	ND	
SBSA57T16W1	lower - SW test pit	09-06-94	NA	ND	Entire wall scraped
SBSA57T17B1	middle - SW test pit	09-06-94	3.5	ND	
SBSA57T17W1	middle - SW test pit	09-06-94	NA	ND	Entire wall scraped

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W35A	middle - SW sidewall	09-07-94	2.7	23	
SBSA57W36	upper - SW sidewall	09-07-94	11	90	
SBSA57W37	upper - NE sidewall	09-07-94	1	273	
SBSA57W38	upper - SW sidewall	09-07-94	0.5	553	
SBSA57W39	upper - NE sidewall	09-07-94	0.7	23	
SBSA57W40	upper - SW sidewall	09-07-94	1	13	
SBSA57W41	upper - NE sidewall	09-07-94	1	147	
SBSA57W42	upper - SW sidewall	09-07-94	0.7	313	
SBSA57W43	middle - NE sidewall	09-07-94	1.8	3,914	
SBSA57W44	middle - SW sidewall	09-07-94	1	3,843	
SBSA57W45	middle - NE sidewall	09-07-94	2.1	1,042	
SBSA57W46	middle - NE sidewall	09-07-94	2.3	4,464	······································
SBSA57W47	middle - NE sidewall	09-07-94	2.1	509	
SBSA57B31	middle - bottom	09-07-94	3.5	14,800	
SBSA57B32	upper - bottom	09-07-94	1	55	
SBSA57B33	upper - bottom	09-07-94	1	14	
SBSA57B34	upper - bottom	09-07-94	1	34	
SBSA57B35	middle - bottom	09-07-94	1.3	142	
SBSA57B36	middle - bottom	09-07-94	1.3	2,109	
SBSA57B37	middle - bottom	09-08-94	4	8,264	
SBSA57B38	middle - bottom	09-08-94	3.8	483	
SBSA57B39	middle - bottom	09-08-94	3.7	ND	
SBSA57W48	middle - NE sidewall	09-08-94	2.4	9	

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SAMPLE D	SAMPLE LOCATION ¹ - GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57W52	middle - NE sidewall	09-08-94	2.8	813	
SBSA57W53	middle - NE sidewall	09-08-94	3.7	8	
SBSA57B41	middle - bottom	09-09-94	4.5	874	
SBSA57B42	middle - bottom	09-09-94	3	564	
SBSA57B43	middle - bottom	09-09-94	2.5	840	
SBSA57B44	middle - bottom	09-09-94	1.5	45	· · · · · · · · · · · · · · · · · · ·
SBSA57B45	middle - bottom	09-09-94	6	ND	
SBSA57W54	middle - SW sidewall	09-09-94	2.5	984	
SBSA57W55	middle - SW sidewall	09-09-94	3	336	· · · · · · · · · · · · · · · · · · ·
SBSA57W56	middle - SW sidewall	09-09-94	2.5	17	
SBSA57W57	middle - SW sidewall	09-09-94	3	503	
SBSA57W58	middle - SW sidewall	09-09-94	2.5	710	
SBSA57W59	upper - SW sidewall	09-09-94	2	1,427	· · · · · · · · · · · · · · · · · · ·
SBSA57W60	upper - SW sidewall	09-09-94	2.3	775	
SBSA57W61	upper - NE sidewall	09-09-94	1	ND	
SBSA57W62	upper - SW sidewall	09-09-94	1.3	206	
SBSA57W63	upper - SW sidewall	09-09-94	1	77	
SBSA57W64	upper - NE sidewall	09-09-94	1.5	1,298	
SBSA57W65	middle - NE sidewall	09-09-94	4	848	
SBSA57W66	middle - NE sidewall	09-09-94	5	7	
SBSA57W67	middle - NE sidewall	09-09-94	4	206	
SBSA57W68	middle - NE sidewall	09-09-94	5	ND	
SBSA57W69	middle - NE sidewall	09-09-94	4	ND	
SBSA57W70	middle - NE sidewall	09-09-94	5	DИ	

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

SAMPLE ID	SAMPLE LOCATION ¹ GENERAL - SPECIFIC	SAMPLE DATE	SAMPLE DEPTH (FT)	TPH RESULT (µg/g)	COMMENTS
SBSA57TP1B	middle- bottom test pit	09-09-94	7.5	9.671	<u>n na seneral de la seconda de la compañía de la compañía</u> Este de la compañía de
SBSA57TP1W1	middle- bottom test pit	09-09-94	5.5	539	
SBSA57TP1W2	middle- bottom test pit	09-09-94	6.5	13,353	
SBSA57TP2B	middle- bottom test pit	09-09-94	6	2,227	
SBSA57TP2W1	middle- bottom test pit	09-09-94	4	ND	
SBSA57TP2W2	middle- bottom test pit	09-09-94	5	ND	
SBSA57TP3B	upper- bottom test pit	09-09-94	5	9,223	
SBSA57TP3W1	upper- bottom test pit	09-09-94	3	5,959	
SBSA57TP3W2	upper- bottom test pit	09-09-94	4	13,119	
SBSA57TP4B	upper- bottom test pit	09-09-94	5.5	549	
SBSA57TP4W1	upper- bottom test pit	09-09-94	3.5	ND	
SBSA57TP4W2	upper- bottom test pit	09-09-94	4.5	ND	
SBSA57TP5B	middle- bottom test pit	09-09-94	9	5,521	
SBSA57TP5W1	middle- bottom test pit	09-09-94	8	9,682	
SBSA57TP5W2	middle- bottom test pit	09-09-94	7	13,908	

NOTES:

¹ Sample location is subdivided into general and specific location - "general" refers to which part of Area 2 (lower is closer to wetland); "specific" refers to whether it was a bottom, sidewall, or testpit sample - refer to Figures 5-3 and 5-4. ND - Indicates non-detect

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NA - Not applicable

Note - Depths are approximate
TABLE 7-8 OHM SOIL REMOVAL OFF-SITE ANALYTICAL RESULTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sample ID	SBSA571	SBSA572	SBSA573	LSSA571	LSSA5702	SBSA57CH1
Date Collected	08-29-94	08-29-94	08-29-94	08-31-94	09-01-94	09-01-94
Matrix	Soil	Soil	Soil	Oil	Oil	Soil
Fuel ID	N/A	N/A	N/A	30% Kerosene	N/A	Kerosene
				70%Lube Oil		Light Lube Oil
<u>TPH¹ (mg/kg)</u>						
light range	1050	624	716	N/A	4000	1380
medium range	3610	3140	2270	N/A	86800	4090
heavy range	36000	35100	26300	N/A	663000	44600
Metals (mg/kg)						
Aluminum	5200	2900	3640	N/A	410	5170
Arsenic	7.8	9.3	7.3	N/A	ND	8.3
Barium	183	37.1	35.8	N/A	53.6	81.1
Cadmium	5.4	ND	ND	N/A	ND	2.5
Calcium	908	322	301	N/A	ND	1010
Chromium	19.7	23.4	19	N/A	12.2	12.8
Copper	53.6	13.2	12.8	N/A	14.4	39.4
Iron	5130	2710	3640	N/A	37.8	4330
Lead	464	199	137	N/A	64.5	306
Magnesium	704	457	734	N/A	ND	536
Manganese	52.6	23.7	32.1	N/A	ND	69.4
Nickel	7.7	5	5.8	N/A	ND	6.6
Potassium	197	155	198	N/A	ND	146
Vanadium	8	ND	6.5	N/A	ND	5.9
Zinc	438	33	41.3	N/A	5.1	139

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TABLE 7-8 OHM SOIL REMOVAL OFF-SITE ANALYTICAL RESULTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sample ID	SBSA571	SBSA572	- SBSA573	LSSA571	LSSA5702	SBSA57CH1
Date Collected	08-29-94	08-29-94	08-29-94	08-31-94	09-01-94	09-01-94
Matrix	Soil	Soil	Soil	Öil	Oil [®]	Soil
Volatiles (mg/kg)						
Ethylbenzene	9.4	ND	ND	N/A	ND	ND
Toluene	12.9	ND	ND	N/A	ND	6.53
Xylenes	63.8	11.6	5.3	N/A	13	25.4
PCBs (mg/kg)						
Aroclor 1242	N/A	N/A	N/A	N/A	29.7	5.8
Aroclor 1254	N/A	N/A	N/A	N/A	28.4	ND
Aroclor 1260	N/A	N/A	N/A	N/A	81.9	4.6

NOTES: ¹ TPH was determined by GC analysis not IR mg/kg = milligrams per kilogram N/A = not applicableND = compound not detected

TABLE 7-9 AREA 1 SOIL REMOVAL ANALYTICAL RESULTS ABOVE REGULATORY LEVELS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sample Identification	Compound	Concentration µg/g	MCP S-1/GW-1 Regulatory Level (µg/g)
AOC57-A1-SW1	PAHs		
	Benzo(a)anthracene	2.36	0.7
	Benzo(b)fluoranthene	4.4	0.7
	Benzo(a)pyrene	2.11	0.7
	Indeno(1,2,3-cd)pyrene	1.75	0.7
AOC57-A1-SW2	EPH		
	C ₁₀ -C ₂₂ Aromatics	532	200
	PAHs		
	Benzo(a)anthracene	7.53	0.7
	Benzo(a)pyrene	8.15	0.7
	Chrysene	10.7	7
	Dibenzo(a,h)anthracene	2.47	0.7
	Indeno(1,2,3-cd)pyrene	6.0	0.7
AOC57-A1-SW4	PAHs		
	Benzo(a)anthracene	3.07	0.7
	Benzo(b)fluoranthene	6.69	0.7
	Benzo(a)pyrene	3.44	0.7
	Dibenzo(a,h)anthracene	1.13	0.7
	Indeno(1,2,3-cd)pyrene	3.02	0.7
AOC57-A1-SW1/B	PAHs		
	Benzo(a)anthracene	2.0	0.7
	Benzo(b)fluoranthene	2.8	0.7
	Benzo(a)pyrene	2.4	0.7
	Indeno(1,2,3-cd)pyrene	1.8	0.7
AOC57-A1-SW4/B	PAHs		
	Benzo(a)anthracene	5.1	0.7
	Benzo(a)pyrene	6.1	0.7
	Benzo(b)fluoranthene	6.1	0.7
	Indeno(1,2,3-cd)pyrene	4.7	0.7

Notes:

μg/g = micrograms per gram

MCP = Massachusetts Contingency Plan

PAHs = polyaromatic hydrocarbons

EPH = extractable petroleum hydrocarbons

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						AREA 2					
anters o Friday	Lab Sample ID:	57E-95-01X	57E-95-01X	57E-95-01X	57E-95-01X	57E-95-02X	57E-95-02X	57E-95-02X	57E-95-03X	57E-95-03X	57E-95-03X
	Date analyzed:	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95						
	Depth (bgs):	0	2	6	9	0	5	10	0	2	5 -
	Dilution:	1.03	1.1	1.05	1.04	1.14	1.12	1.03	1.08	1.14	1.03
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA	NA	NA	NA						
1,1-DCE	5 μg/kg/250 μg/kg	5.2 U	5.5 U	5.3 U	5.2 U	5.7 U	5.6 U	5.2 U	5.4 U	5.7 U	5.2 U
t-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA						
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA						
Chloroform	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 UJ	2.2 UJ	2.1 UJ	2.1 UJ	2.3 UJ	2.2 UJ	2.1 UJ	2.2 UJ	2.3 UJ	2.1 UJ
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Trichloroethene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2. 1 U	2.2 U	2.3 U	2.1 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA						
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	' NA	NA	NA	NA
1,2-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA						
Benzene	2 μg/kg/250 μg/kg	2.1 UJ	2.2 UJ	2.1 UJ	2.1 U	2.3 UJ	2.2 U	2.1 UJ	2.2 UJ	2.3 U	2.1 UJ
Toluene	2 μg/kg/250 μg/kg	2.1 U	3.2	2.1 U	2.1 UJ	2.3 U	2.2 UJ	2.1 U	2.3	2.3 UJ	2.1 U
Chlorobenzene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.1 U	4.4 U	4.2 U	4.2 U	4.6 U	4.5 U	4.1 U	4.3 U	4.6 U	4.1 U
o-Xylene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.1 U	2.1 U	2.3 U	2.2 U	2.1 U	2.2 U	2.3 U	2.1 U
Naphthalene	2 μg/kg/250 μg/kg	NA	NA	NA	NA						
TPH-DRO	100 mg/kg	NA	NA	NA	NA						
TPH-GRO	100 µg/kg	100 U	110 U	110 U	100 U	110 U	110 U	100 U	110 U	110 U	100 U
TPH-IR (1995)	50 mg/kg	52 U	73	53 U	52 U	69	56 U	52 U	54 U	57 U	52 U
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA						

Notes:

Detection limits are reported for 1995/1996 field programs.

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting limit

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 2										
	Lab Sample ID:	57E-95-03X	57E-95-04X	57E-95-04X	57E-95-04X	57E-95-05X	57E-95-05X	57E-95-05X	57E-95-06X	57E-95-06X	57E-95-06X	
	Date analyzed:	29-Sep-95	9-Oct-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	
	Depth (bgs):	10	0	5	12	0	6	13	0	6	11	
	Dilution:	1.03	1.05	1.04	1.04	1.11	1.02	1.03	1.06	1.03	1.05	
Analytes	Reporting Limit 1995/1996											
Vinyl Chloride	2 μg/kg/250 μg/kg	NA										
1,1-DCE	5 μg/kg/250 μg/kg	5.2 U	NA	5.2 U	5.2 U	5.6 U	5.1 U	5.2 U	5.3 U	5.2 U	5.3 U	
t-1,2-DCE	2 μg/kg/250 μg/kg	NA										
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	ŇA	NA								
Chloroform	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U	
1,1,1-TCA	2 μg/kg/250 μg/kg	2.1 UJ	NA	2.1 UJ	2.1 UJ	2.2 UJ	2.0 U	2.1 UJ	2.1 UJ	2.1 UJ	2.1 U	
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U	
Trichloroethene	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U	
Tetrachloroethene	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U	
1,3-DCB	2 μg/kg/250 μg/kg	NA										
1,4-DCB	2 μg/kg/250 μg/kg	NA										
1,2-DCB	2 μg/kg/250 μg/kg	NA										
Benzene	2 μg/kg/250 μg/kg	2.1 UJ	NA	2.1 U	2.1 U	2.2 UJ	2.0 U	2.1 U	2.1 U	2.1 U	2.1 U	
Toluene	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 UJ	2.1 UJ	2.2 U	2.0 UJ	2.1 UJ	2.5 J	2.1 UJ	2.4 J	
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	2.3	
Ethylbenzene	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	22 E	
m/p-Xylene	4 μg/kg/500 μg/kg	4.1 U	NA	4.2 U	4.2 U	4.4 U	4.1 U	4.1 U	4.2 U	4.1 U	22 E	
o-Xylene	2 μg/kg/250 μg/kg	2.1 U	NA	2.1 U	2.1 U	2.2 U	2.0 U	2.1 U	2.1 U	2.1 U	25 E	
Naphthalene	2 μg/kg/250 μg/kg	NA										
TPH-DRO	100 mg/kg	NA	'NA	NA								
TPH-GRO	100 µg/kg	100 U	NA	100 U	100 U	110 U	100 U	100 U	110 U	100 U	110 U	
TPH-IR (1995)	50 mg/kg	52 U	53 U	52 U	52 U	56 U	51 U	52 U	53 U	52 U	53 U	
TPH-IR (1996)	50 mg/kg	NA										

Notes:

Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 2											
THE PARTY ST REAL PRODUCTION	Lab Sample ID:	57E-95-07X	57E-95-07X	57E-95-07X	57E-95-08X	57E-95-08X	57E-95-08X	57E-95-09X	57E-95-09X	57E-95-09X	57E-95-10X		
	Date analyzed:	29-Sep-95	4-Oct-95	4-Oct-95	3-Oct-95	Oct-95	4-Oct-95	4-Oct-95	4-Oct-95	4-Oct-95	29-Sep-95		
	Depth (bgs):	0	4	7	0	- 4	6	0	5	8	0		
and white the second second	Dilution:	1.11	390	2.5	1.43	1.49	1.18	1.1	1.37	1.22	1.11		
Analytes	Reporting Limit 1995/1996												
Vinyl Chloride	2 μg/kg/250 μg/kg	NA											
1,1-DCE	5 μg/kg/250 μg/kg	5.6 U	6100 E	13 U	7.2 U	7.5 U	5.9 U	5.5 U	6.9 U	6.1 U	5.6 U		
t-1,2-DCE	2 μg/kg/250 μg/kg	NA											
c-1,2-DCE	2 μg/kg/250 μg/kg	NA											
Chloroform	2 μg/kg/250 μg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
1,1,1-TCA	2 µg/kg/250 µg/kg	2.2 UJ	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
Trichloroethene	2 μg/kg/250 μg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
Tetrachloroethene	2 μg/kg/250 μg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
1,3-DCB	2 μg/kg/250 μg/kg	NA											
1,4-DCB	2 μg/kg/250 μg/kg	NA											
1,2-DCB	2 µg/kg/250 µg/kg	NA											
Benzene	2 μg/kg/250 μg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
Toluene	2 µg/kg/250 µg/kg	2.2 UJ	3400	5.0 U	2.9 Ŭ	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.4 J		
Chlorobenzene	2 μg/kg/250 μg/kg	2.2 U	780 U	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
Ethylbenzene	2 μg/kg/250 μg/kg	2.2 U	14000	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
m/p-Xylene	4 μg/kg/500 μg/kg	4.4 U	56000	10 U	5.7 U	6.0 U	4.7 U	4.4 U	5.5 U	4.9 U	4.4 U		
o-Xylene	2 μg/kg/250 μg/kg	2.2 U	36000	5.0 U	2.9 U	3.0 U	2.4 U	2.2 U	2.7 U	2.4 U	2.2 U		
Naphthalene	2 μg/kg/250 μg/kg	NA											
TPH-DRO	100 mg/kg	NA											
TPH-GRO	100 μg/kg	110 U	8.6 e+ 6E	250	140 U	150 U	120 U	110 U	140 U	120 U	110 U		
TPH-IR (1995)	50 mg/kg	61	65000	130 U	1400	75 U	59 U	55 U	69 U	61 U	80		
TPH-IR (1996)	50 mg/kg	NA											

Notes:

Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						ARE	EA 2				
the second transformer	Lab Sample ID:	57E-95-10X	57E-95-10X	57E-95-11X	57E-95-11X	57E-95-11X	57E-95-12X	57E-95-12X	57E-95-12X	57E-95-13X	57E-95-13X
	Date analyzed:	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	29-Sep-95	3-Oct-95	3-Oct-95	4-Oct-95	3-Oct-95	3-Oct-95
	Depth (bgs):	6	10		6	- 13 -	- 0	4	. 13	0	- 5
	Dilution:	1.05	1.02	1.04	1.04	1.03	1.08	3.12	1.33	1.23	1.19
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA									
1,1-DCE	5 μg/kg/250 μg/kg	5.3 U	5.1 U	5.2 U	5.2 U	5.2 U	5.4 U	16 U	6.7 U	6.2 U	6.0 U
t-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	'NA	NA	NA	NA	NA
c-1,2-DCE	2 µg/kg/250 µg/kg	NA									
Chloroform	2 μg/kg/250 μg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 Ŭ
1,1,1 - TCA	2 μg/kg/250 μg/kg	2.1 UJ	2.0 U	2.1 U	2.1 U	2.1 UJ	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Trichloroethene	2 μg/kg/250 μg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
1,3-DCB	2 μg/kg/250 μg/kg	NA									
1,4-DCB	2 μg/kg/250 μg/kg	NA									
1,2-DCB	2 µg/kg/250 µg/kg	NA									
Benzene	2 μg/kg/250 μg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 UJ	2.2 U	6.2 U	2.7 U	2.5 U	2.4 U
Toluene	2 µg/kg/250 µg/kg	2.1 UJ	2.0 UJ	2.1 UJ	2.1 UJ	2.1 U	2.2 U	20	2.7 U	2.5 U	2.4 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	42	2.7 U	2.5 U	2.4 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	65	2.7 U	2.5 U	2.4 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.2 U	4.1 U	4.2 U	4.2 U	4.1 U	4.3 U	97	5.3 U	4.9 U	4.8 U
o-Xylene	2 μg/kg/250 μg/kg	2.1 U	2.0 U	2.1 U	2.1 U	2.1 U	2.2 U	220	2.7 U	2.5 U	2.4 U
Naphthalene	2 μg/kg/250 μg/kg	NA									
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	110 U	NA	NA	NA	NA
TPH-GRO	100 μg/kg	110 U	100 U	100 U	100 U	100 U	110 U	79000 E	130 U	120 U	120 U
TPH-IR (1995)	_. 50 mg/kg	53 U	51 U	75	52 U	130	9700	1400	67 U	110	60 U
TPH-IR (1996)	50 mg/kg	NA									

Notes:

Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 2									
AND A SALE OF MARK	Lab Sample ID:	57E-95-13X	57E-95-14X	57E-95-14X	57E-95-14X	57E-95-15X	57E-95-15X	57E-95-15X	57E-95-16X	57E-95-16X	57E-95-16X
	Date analyzed:	3-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95	4-Oct-95	5-Oct-95	4-Oct-95	4-Oct-95	4-Oct-95	4-Oct-95
	Depth (bgs):	11	0	2	6	0	2	5	0	3	- 5
	Dilution:	1.22	1.03	1.69	1.2	1.32	1.64	1.12	1.25	1.04	1.43
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 μg/kg/250 μg/kg	6.1 U	5.2 U	8.5 U	6.0 U	6.6 UJ	8.2 U	5.6 U	6.3 U	5.2 UJ	7.2 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
1,1,1-TCA	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	[·] 3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Trichloroethene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	2.2 U	2.5 U	2.1 U	2.9 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	4.8	2.2 U	2.5 U	2.1 U	2.9 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	3.3 U	. 2.2 U	2.5 U	2.1 U	2.9 U
Toluene	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	5.6	2.2 U	2.5 U	65	2.9 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	16	2.2 U	2.5 U	2.1 U	2.9 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	54	2.2 U	2.5 U	7.9	2.9 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.9 U	4.1 U	6.8 U	4.8 U	5.3 U	75	4.5 U	5.0 U	4.2 U	5.7 U
o-Xylene	2 μg/kg/250 μg/kg	2.4 U	2.1 U	3.4 U	2.4 U	2.6 U	170	2.2 U	2.5 U	2.1 U	2.9 U
Naphthalene	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	120 U	NA	170 U	120 U	NA	900	NA	NA	NA	NA
TPH-GRO	100 µg/kg	120 U	100 U	170 U	120 U	130 U	49000 E	110 U	130 U	100 U	140 U
TPH-IR (1995)	50 mg/kg	61 U	52 U	160	60 U	5000	28000	56 U	120	8000	72 Ŭ
TPH-IR (1996)	50 mg/kg	ŇA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						ARI	EA 2				
Section States	Lab Sample ID:	57E-95-17X	57E-95-17X	57E-95-17X	57E-95-18X	57E-95-18X	57E-95-18X	57E-95-19X	57E-95-19X	57E-95-19X	57E-95-20X
	Date analyzed:	4-Oct-95	5-Oct-95	5-Oct-95	5-Oct-95	4-Oct-95	5-Oct-95	5-Oct-95	4-Oct-95	5-Oct-95	4-Oct-95
	Depth (bgs):	0	2	5	0	2	3	0	2	3	0
	Dilution:	1.23	1.45	5.9	1.43	1.28	1.25	1.02	1.39	1.28	1.08
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA									
1,1-DCE	5 μg/kg/250 μg/kg	6.2 UJ	7.3 U	30 U	7.2 U	6.4 U	6.3 U	5.1 U	7.0 UJ	6.4 U	5.4 U
t-1,2-DCE	2 μg/kg/250 μg/kg	NA									
c-1,2-DCE	2 μg/kg/250 μg/kg	NA									
Chloroform	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	4.9	2.0 U	2.8 U	2.6 U	2.2 U
1,1,1-TCA	2 μg/kg/250 μg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Trichloroethene	2 μg/kg/250 μg/kg	2.5 U	2.9 U	21	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Tetrachloroethene	2 µg/kg/250 µg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
1,3-DCB	2 μg/kg/250 μg/kg	NA									
1,4-DCB	2 μg/kg/250 μg/kg	NA									
1,2-DCB	2 µg/kg/250 µg/kg	NA									
Benzene	2 μg/kg/250 μg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Toluene	2 μg/kg/250 μg/kg	2.5 U	2.9 U	12 U	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Chlorobenzene	2 μg/kg/250 μg/kg	2.5 U	2.9 U	150	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.5 U	2.9 U	71	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.9 U	5.8 U	72	5.7 U	5.1 U	5.0 U	4.1 U	5.6 U	5.1 U	4.3 U
o-Xylene	2 μg/kg/250 μg/kg	2.5 U	2.9 U	220	2.9 U	2.6 U	2.5 U	2.0 U	2.8 U	2.6 U	2.2 U
Naphthalene	2 μg/kg/250 μg/kg	NA									
TPH-DRO	100 mg/kg	NA	150 U	120	NA						
TPH-GRO	100 μg/kg	120 U	5800 E	52000 E	550	130 U	130 U	100 U	140 U	130 U	110 U
TPH-IR (1995)	50 mg/kg	3400	2000	620	72 U	64 U	63 U	68	70 U	64 U	54 U
TPH-IR (1996)	50 mg/kg	NA									

Notes:

Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		An Service Lowest				ARI	EA 2		and the second second		
A GAR BURNER AND THE	Lab Sample ID:	57E-95-20X	57E-95-20X	57E-95-25X	57E-95-25X	57E-95-25X	57E-95-26X	57E-95-26X	-57E-95-26X	57E-95-27X	57E-95-27X
	Date analyzed:	4-Oct-95	4-Oct-95	28-Sep-95	28-Sep-95	28-Sep-95	28-Sep-95	28-Sep-95	6-Oct-95	6-Oct-95	6-Oct-95
	Depth (bgs):	3	5	0	2	12	0	5	11	0	2
	Dilution:	1.05	1.16	1.03	1.12	1.03	1.03	1.04	1.04	1.07	1.12
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-DCE	5 μg/kg/250 μg/kg	5.3 UJ	5.8 U	5.2 U	5.6 U	5.2 U	5.2 U	5.2 U	5.2 U	5.4 U	5.6 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	2 μg/kg/250 μg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
1,1,1-TCA	2 μg/kg/250 μg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.5	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 UJ	2.1 U	2.1 U	2.2 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	-2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.2 U	4.6 U	4.1 U	4.5 U	4.1 U	4.1 U	4.2 U	4.2 U	4.3 U	4.5 U
o-Xylene	2 μg/kg/250 μg/kg	2.1 U	2.3 U	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.2 U
Naphthalene	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	. NA	NA	NA	NA	ŇA	NA	NA	NA	NA
TPH-GRO	100 μg/kg	110 U	120 U	100 U	110 U	100 U	100 U	100 U	100 U	110 U	110 U
TPH-IR (1995)	50 mg/kg	3400	58 U	52 U	480	52 U	260	52 U	52 U	98	82
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Detection limits are reported for 1995/1996 field prog

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U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 2				AREA 3					5.8.8.8
and Statement of the Statement	Lab Sample ID:	57E-95-27X	57E-95-21X	57E-95-21X	57E-95-21X	57E-95-22X	57E-95-22X	57E-95-22X	57E-95-23X	57E-95-23X	57E-95-23X
	Date analyzed:	6-Oct-95	5-Oct-95	5-Oct-95	5-Oct-95	6-Oct-95	5-Oct-95	5-Oct-95	6-Oct-95	5-Oct-95	5-Oct-95
	Depth (bgs):	12	0	- 6	10	0	4	10	0	4	10
	Dilution:	1.04	1.22	1.09	1.03	1.16	1.11	1.03	1.15	1.03	1.04
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 µg/kg/250 µg/kg	NA									
1,1-DCE	5 μg/kg/250 μg/kg	5.2 U	6.1 U	5.5 U	5.2 U	5.8 U	5.6 U	5.2 U	5.8 U	5.2 U	5.2 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA									
c-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA NA								
Chloroform	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Trichloroethene	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 Ŭ	2.1 U	2.3 U	2.1 U	2.1 U
1,3-DCB	2 μg/kg/250 μg/kg	NA									
1,4-DCB	2 µg/kg/250 µg/kg	NA									
1,2-DCB	2 μg/kg/250 μg/kg	NA									
Benzene	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Toluene	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.7	2.1 U	2.3 U	2.1 U	2.1 U
Ethylbenzene	2 µg/kg/250 µg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2. 1 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.2 U	4.9 U	4.4 U	4.1 U	4.6 U	4.4 U	4.1 U	4.6 U	4.1 U	4.2 U
o-Xylene	2 μg/kg/250 μg/kg	2.1 U	2.4 U	2.2 U	2.1 U	2.3 U	2.2 U	2.1 U	2.3 U	2.1 U	2.1 U
Naphthalene	2 μg/kg/250 μg/kg	NA									
TPH-DRO	100 mg/kg	NA									
TPH-GRO	100 µg/kg	100 U	120 U	110 U	100 U	120 U	110 U	100 U	460	100 U	100 U
TPH-IR (1995)	50 mg/kg	52 U	160	55 U	52 U	58 U	56 U	52 U	58 U	52 U	52 U
TPH-IR (1996)	50 mg/kg	NA									

Notes:

Detection limits are reported for 1995/1996 field prog

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						AREA 3					
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	Lab Sample ID:	57E-95-24X	57E-95-24X	57E-95-24X	57E-95-24X	57E-96-28X	57E-96-28X	57E-96-28X	57E-96-28X	57E-96-28X	57E-96-29X
States of Conservation	Date analyzed:	5-Oct-95	6-Oct-95	5-Oct-95	5-Oct-95	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96
	Depth (bgs):	0.	4	7	10	3	6	8	9	10	4
ALL REPORT OF THE REPORT OF THE	Dilution:	1.09	1.27	1.04	1.25	130	138	.134	159	155	131
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA	NA	NA	NA	260 U	280 U	270 U	320 U	310 U	260 U
1,1-DCE	5 μg/kg/250 μg/kg	5.5 U	6.4 U	5.2 U	6.3 U	260 U	280 U	270 U	320 U	310 U	260 U
t-1,2-DCE	2 µg/kg/250 µg/kg	NA	NA	NA	NA	260 U	280 U	270 U	320 U	310 U	260 U
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	260 U	280 U	270 U	320 U	310 U	260 U
Chloroform	2 μg/kg/250 μg/kg	2.2 U	2.5 U	6.2	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
1,1,1-TCA	2 µg/kg/250 µg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Trichloroethene	2 μg/kg/250 μg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA NA	ŇA	NA	NA	NA
1,4-DCB	2 μg/kg/250 μg/kg	NA									
1,2-DCB	2 µg/kg/250 µg/kg	NA									
Benzene	2 μg/kg/250 μg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Toluene	2 μg/kg/250 μg/kg	2.2 U	2.5 U	2.1 U	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Chlorobenzene	2 µg/kg/250 µg/kg	2.2 U	2.5 U	19	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.2 U	2.5 U	15	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
m/p-Xylene	4 μg/kg/500 μg/kg	4.4 U	5.7	20	5.0 U	520 U	560	540 U	640 U	620 U	520 U
o-Xylene	2 µg/kg/250 µg/kg	2.2 U	27	5.8	2.5 U	260 U	280 U	270 U	320 U	310 U	260 U
Naphthalene	2 μg/kg/250 μg/kg	NA	• NA								
TPH-DRO	100 mg/kg	NA	180	310	NA						
TPH-GRO	100 µg/kg	110 U	32000 E	33000 E	130 U	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	55 U	33000	6000	63 U	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	51 U	16000	1500	170	160	1200

Notes:

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J = Value is estimated

E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						AREA 3	200 C 40 F 40			1.5 SP. 2-5 SP.	
Contraction of the	Lab Sample ID:	57E-96-29X	57E-96-29X	57E-96-29X	57E-96-29X	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-30X
	Date analyzed:	20-Aug-96	20-Aug-96	20-Aug-96	20-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96
	Depth (bgs):	5	7	10	11	2	- 4	4D	5	5A	6 -
	Dilution:	135	138	158	153	135	138	138	140	131	130
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
1,1-DCE	5 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
t-1,2-DCE	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
c-1,2-DCE	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Chloroform	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
1,1,1 - TCA	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Trichloroethene	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Tetrachloroethene	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Toluene	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Chlorobenzene	2 µg/kg/250 µg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	280 U	260 U	260 U
Ethylbenzene	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	3000	260 U	490
m/p-Xylene	4 μg/kg/500 μg/kg	540 U	550 U	630 U	610 U	540 U	550 U	550 U	13000	580	2600
o-Xylene	2 μg/kg/250 μg/kg	270 U	280 U	320 U	310 U	270 U	280 U	280 U	8000	790	1200
Naphthalene	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	4500	57 U	63	160	15000	15000	NA	53000 E	1000	<u> </u>

Notes:

Detection limits are reported for 1995/1996 field prog

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E = Concentration exceeds the maximum reporting

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 3									
Search Marcine Strates and	Lab Sample ID:	57E-96-30X	57E-96-30X	57E-96-30X	57E-96-31X						
The arth states a	Date analyzed:	22-Aug-96	22-Aug-96	22-Aug-96	27-Aug-96	26-Aug-96	26-Aug-96	27-Aug-96	27-Aug-96	27-Aug-96	27-Aug-96
	Depth (bgs):	9 .	9A	11	4	6	ഇ	- 7.	9	. 10	9A
	Dilution:	151	160	161	675	135	135	134	740	1500	161
Analytes	Reporting Limit 1995/1996										
Vinyl Chlo r ide	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,1-DCE	5 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
t-1,2-DCE	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
c-1,2-DCE	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Chloroform	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,1,1-TCA	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Trichloroethene	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Tetrachloroethene	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
1,2-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Benzene	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Toluene	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Chlorobenzene	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1400 U	270 U	270 U	270 U	1500 U	3000 U	320 U
Ethylbenzene	2 μg/kg/250 μg/kg	300 U	320 U	320 U	1800	270 Ŭ	270 U	270 U	1500 U	8800	320 U
m/p-Xylene	4 μg/kg/500 μg/kg	600 U	640 U	640 U	4000	540 U	540 U	540 U	3000 U	26000	640 U
o-Xylene	2 µg/kg/250 µg/kg	300 U	320 U	320 U	1600	270 U	270 U	270 U	1500 U	9900	320 U
Naphthalene	2 μg/kg/250 μg/kg	NA	NA	NA	5800 J	560	270 U	870 J	3800 J	12000 J	320 U
TPH-DRO	100 mg/kg	NA	NA NA								
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA NA	NA NA	NA	NA	NA NA	NA NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA NA	NA	NA NA	NA	NA	NA NA	NA
TPH-IR (1996)	50 mg/kg	610	1100	410	63000 E	10000	14000	55 U	9400 E	13000 E	65

Notes:

Detection limits are reported for 1995/1996 field prog

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 2									AREA 3
	Lab Sample ID:	57B-95-03X	57B-95-03X	57B-95-04X	57B-95-05X	57B-95-06X	57M-95-07X	57M-95-08A	57M-95-08B	57P-95-01A	57R-95-01X
	Date analyzed:	10-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	12-Oct-95	12-Oct-95	12-Oct-95	12-Oct-95	10-Oct-95
	Depth (bgs):	. 0	5	15	15	12	4	7	. 4	. 5	0
	Dilution:	1.07	1.04	1.26	1.32	1.21	1.23	1.27	1.29	1.28	1.07
Analytes	Reporting Limit										
	1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA NA	NA	NA	NA	NA
1,1-DCE	5 µg/kg/250 µg/kg	5.4 UJ	5.2 UJ	6.3 UJ	6.6 UJ	6.1 UJ	6.2 UJ	6.4 UJ	6.5 UJ	6.4 UJ	5.4 J
t-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA NA	NA	NA	NA	NA
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA NA	NA	NA	NA	NA NA
Chloroform	2 μg/kg/250 μg/kg	2.1 U	2.1 UJ	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
1,1,1-TCA	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Trichloroethene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	NA	NA NA	NA	NA	NA	NA NA
1,4-DCB	2 µg/kg/250 µg/kg	NA									
1,2-DCB	2 µg/kg/250 µg/kg	NA	NA	NA NA	NA	NA	NA NA	NA	NA	NA	NA NA
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Toluene	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Chlorobenzene	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
m/p-Xylene	4 μg/kg/540 μg/kg	4.3 U	4.2 U	5.0 U	5.3 U	4.8 U	4.9 U	5.1 U	5.2 U	5.1 U	4.3 U
o-Xylene	2 μg/kg/250 μg/kg	2.1 U	2.1 U	2.5 U	2.6 U	2.4 U	2.5 U	2.5 U	2.6 U	2.6 U	2.1 U
Naphthalene	2 µg/kg/250 µg/kg	NA	NA	NA	NA NA	NA	NA	NA	NA	NA	NA NA
TPH-DRO	100 mg/kg	NA	NA	NA NA	NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	110 U	100 U	130 U	130 U	120 U	120 U	130 U	130 U	130 U	110U
TPH-IR (1995)	50 mg/kg	480	52 U	63 U	66 U	61 U	62 U	64 U	65	64 U	54 Ŭ
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA NA	NA	NA	NA	NA	NA	NA

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting limit

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREAS									
	Lab Sample ID:	57R-95-01X	57R-95-01X	57R-95-02X	57R-95-02X	57R-95-02X	57R-95-03X	57R-95-03X	57R-95-03X	57R-95-04X	57R-95-04X
	Date analyzed:	10-Oct-95	10-Oct-95	10-Oct-95	10-Oct-95	10-Oct-95	10-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95
	Depth (bgs):	6	12	. 0	- 4	10	• 0	4	10	0	. 4
	Dilution:	1.04	1,11	1.08	1.09	1.33	1.08	1.04	1.31	1.08	1.05
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA									
1,1-DCE	5 μg/kg/250 μg/kg	5.2 UJ	5.6 UJ	5.4 UJ	5.5 UJ	6.7 UJ	5.4 UJ	5.2 UJ	6.6 UJ	5.4 UJ	5.3 UJ
t-1,2-DCE	2 µg/kg/250 µg/kg	NA									
c-1,2-DCE	2 μg/kg/250 μg/kg	NA									
Chloroform	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 UJ	2.6 U	2.2 UJ	2.1 UJ
1,1,1-TCA	2 µg/kg/250 µg/kg	2.1 UJ	2.2 U	2.2 U	2.2 U	2.7 U	2.2 UJ	2.1 U	2.6 UJ	2.2 U	2.1 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Trichloroethene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
1,3-DCB	2 µg/kg/250 µg/kg	NA									
1,4-DCB	2 μg/kg/250 μg/kg	NA									
1,2-DCB	2 μg/kg/250 μg/kg	NA									
Benzene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Toluene	2 µg/kg/250 µg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Chlorobenzene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
m/p-Xylene	4 μg/kg/540 μg/kg	4.2 U	4.4 U	4.3 U	4.4 Ŭ	5.3 U	4.3 U	4.2 U	5.2 U	4.3 U	4.2 U
o-Xylene	2 μg/kg/250 μg/kg	2.1 U	2.2 U	2.2 U	2.2 U	2.7 U	2.2 U	2.1 U	2.6 U	2.2 U	2.1 U
Naphthalene	2 μg/kg/250 μg/kg	NA									
TPH-DRO	100 mg/kg	NA									
TPH-GRO	100 µg/kg	100 U	110 U	110 U	110 U	130 U	110 U	100 U	130 U	110 U	110 U
TPH-IR (1995)	50 mg/kg	52 U	56 U	140	55 U	67 U	450	52 U	400	95	440
TPH-IR (1996)	50 mg/kg	NA									

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		-	物的过去分词			ARI	CA3	e de grade de seu		NOT THE POPULATION	的基本标题员
的复数形式的复数	Lab Sample ID:	57R-95-04X	57R-95-05X	57R-95-05X	57R-95-05X	57B-96-07X	57B-96-07X	57B-96-07X	57B-96-08X	57B-96-08X	57B-96-08X
	Date analyzed:	10-Oct-95	11-Oct-95	11-Oct-95	11-Oct-95	29-Aug-96	Aug-96	29-Aug-96	3-Sep-96	29-Aug-96	3-Sep-96
A Constant of Constant	Depth (bgs):	10	0	4	10	0	5	10	0	5	10
	Dilution:	1.3	1.06	1.06	2.64	680	800	166	133	166	161
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	NA	NA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
1,1-DCE	5 μg/kg/250 μg/kg	6.5 UJ	5.3 UJ	5.3 UJ	13 UJ	1400 U	1600 U	330 U	270 U	330 U	320 U
t-1,2-DCE	2 μg/kg/250 μg/kg	NA	ŇA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
c-1,2-DCE	2 μg/kg/250 μg/kg	NA	NA	NA	NA	1400 U	1600 U	330 U	270 U	330 U	320 U
Chloroform	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	· 270 U	330 U	320 U
1,1,1-TCA	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Trichloroethene	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Tetrachloroethene	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	1400 Ŭ	1600 U	330 U	270 U	330 U	320 U
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	1400 U	14000	330 U	270 U	330 U	320 U
1,2-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	NA	1400 U	46000	330 U	270 U	330 U	320 U
Benzene	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Toluene	2 μg/kg/250 μg/kg	2.6 Ŭ	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Chlorobenzene	2 μg/kg/250 μg/kg	49	2.1 U	2.1 U	5.3 U	1400 U	1600 U	330 U	270 U	330 U	320 U
Ethylbenzene	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	5.3 U	1400 U	11000	330 U	270 U	330 U	320 U
m/p-Xylene	4 μg/kg/540 μg/kg	5.2 U	4.2 U	4.2 U	11 U	2700 U	58000	730	530 U	660 U	640 U
o-Xylene	2 μg/kg/250 μg/kg	2.6 U	2.1 U	2.1 U	9.9	1400 U	28000	720	270 U	330 U	320 U
Naphthalene	2 μg/kg/250 μg/kg	NA	NA	NA	NA	2300 J	27000 J	440 J	270 U	330 U	320 U
TPH-DRO	100 mg/kg	ŇĂ	NA	110	130 U	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	130 U	110 U	4400 E	2100	NA	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	65 U	190	4500	180	NA	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	NA	NA	NA	NA	12000 E	14000 E	190	53	66 U	64 U

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

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NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA'3									
	Lab Sample ID:	57B-96-09X	57B-96-09X	57B-96-09X	57M-96-09X	57M-96-09X	57M-96-09X	57M-96-09X	57M-96-09X	57B-96-10X	57B-96-10X
	Date analyzed:	3-Sep-96	Aug-96	29-Aug-96	5-Sep-96	5-Sep-96	6-Sep-96	9-Sep-96	9-Sep-96	9-Sep-96	9-Sep-96
	Depth (bgs):	0	- 5	10	0	4	9	14	19	5	10
STRATE AND A STREET	Dilution:	130	153	174	133	130	131	158	160	131	163
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,1-DCE	5 μg/kg/250 μg/kg	260 U	310 U	370	270 UJ	260 UJ	260 U	320 U	320 U	260 U	330 U
t-1,2-DCE	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
c-1,2-DCE	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Chloroform	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,1,1-TCA	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Trichloroethene	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Tetrachloroethene	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,3-DCB	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,4-DCB	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
1,2-DCB	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Benzene	2 μg/kg/250 μg/kg	260 U	310 U	350 Ŭ	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Toluene	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Chlorobenzene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
Ethylbenzene	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
m/p-Xylene	4 μg/kg/540 μg/kg	520 U	610 U	700 U	530 U	520 U	520 U	630 U	640 U	520 U	650 U
o-Xylene	2 μg/kg/250 μg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U) 330 U
Naphthalene	2 µg/kg/250 µg/kg	260 U	310 U	350 U	270 U	260 U	260 U	320 U	320 U	260 U	330 U
TPH-DRO	100 mg/kg	NA	NA NA) NA							
TPH-GRO	100 μg/kg	NA									
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	· NA	NA	NA	NA	NA NA
TPH-IR (1996)	50 mg/kg	150	61 U	70 U	53 U	52 U	52 U	63 U	64 U	52 U	65

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA3									
a geographic and the	Lab Sample ID:	57B-96-10X	57B-96-11X	57B-96-11X	57B-96-11X	57B-96-11X	57B-96-12X	57R-95-06X	57R-96-07X	57R-96-07X	57R-96-07X
	Date analyzed:	Sep-96	10-Sep-96	10-Sep-96	10-Sep-96	10-Sep-96	10-Sep-96	11-Oct-95	21-Aug-96	21-Aug-96	21-Aug-96
	Depth (bgs):	15	- 5	10	10D	15	5	10	2	6	10
	Dilution:	175	136	155	161	163	1490	1.29	131	133	165
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	260 U	270 U	330 U
1,1-DCE	5 μg/kg/250 μg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	6.5 UJ	260 U	270 U	330 U
t-1,2-DCE	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	260 U	270 U	330 U
c-1,2-DCE	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	260 U	270 U	330 U
Chloroform	2 μg/kg/250 μg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
1,1,1-TCA	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Trichloroethene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Tetrachloroethene	2 μg/kg/250 μg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
1,3-DCB	2 μg/kg/250 μg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	NA	NA	NA
1,4-DCB	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	NA	NA	NA
1,2-DCB	2 μg/kg/250 μg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	NA	NA	NA	NA
Benzene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Toluene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
Chlorobenzene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	4700	2.6 U	260 U	270 U	330 U
Ethylbenzene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	3000 U	2.6 U	260 U	270 U	330 U
m/p-Xylene	4 μg/kg/540 μg/kg	700 U	540 U	620 U	640 U	650 U	13000	5.2 U	520 U	530 U	660 U
o-Xylene	2 µg/kg/250 µg/kg	350 U	270 U	310 U	320 U	330 U	4700	2.6 U	260 U	270 U	330 U
Naphthalene	2 μg/kg/250 μg/kg	350 U	270 U	310 U	320 U	330 U	8300	NA	NA	NA	NA
TPH-DRO	100 mg/kg	NA									
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA	NA	130 U	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA	NA NA	65 U	NA	NA	NA NA
TPH-IR (1996)	50 mg/kg	70	7400	62 U	64 U	65 U	13000 E	NA	52 U	53 U	66

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

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NA = Not analyzed

B = Analyte found in method blank

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 3									
	Lab Sample ID:	57R-96-08X	57R-96-08X	57R-96-08X	57R-96-08X	57R-96-09X	57R-96-09X	57R-96-09X	57R-96-10X	57R-96-10X	57R-96-10X
	Date analyzed:	21-Aug-96	21-Aug-96	21-Aug-96	21-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	22-Aug-96	23-Aug-96
	Depth (bgs):	2	2D	6	10	2	6	10	2	6	10
Sub-Sub-Sub-Sub-Sub-Sub-Sub-Sub-Sub-Sub-	Dilution:	133	133	133	159	130	134	155	133	135	149
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 µg/kg/250 µg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
1,1-DCE	5 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
t-1,2-DCE	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
c-1,2-DCE	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Chloroform	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
1,1,1-TCA	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Trichloroethene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Tetrachloroethene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	NA NA	NA	NA						
1,4-DCB	2 μg/kg/250 μg/kg	NA									
1,2-DCB	2 μg/kg/250 μg/kg	NA									
Benzene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Toluene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Chlorobenzene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
Ethylbenzene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 U	300 U
m/p-Xylene	4 μg/kg/540 μg/kg	530 U	530 U	530 U	640 U	520 U	540 U	620 U	530 U	540 U	600 U
o-Xylene	2 μg/kg/250 μg/kg	270 U	270 U	270 U	320 U	260 U	270 U	310 U	270 U	270 Ŭ	1900
Naphthalene	2 μg/kg/250 μg/kg	NA									
TPH-DRO	100 mg/kg	NA									
TPH-GRO	100 µg/kg	NA									
TPH-IR (1995)	50 mg/kg	NA									
TPH-IR (1996)	50 mg/kg	53 U	NA	53 U	64 U	52 U	54 U	62	150	54 U	60

Notes:

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NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						ARI	BA3	A STATE OF A			
Versesses	Lab Sample ID:	57R-96-10X	57R-96-11X	57R-96-11X	57R-96-11X	57R-96-12X	57R-96-12X	57R-96-12X	57R-96-12X	57R-96-13X	57R-96-13X
아이는 아이는 것을 알 것 같다.	Date analyzed:	23-Aug-96	26-Aug-96	26-Aug-96.	27-Aug-96						
	Depth (bgs):	10D	2.	6	10	2	6	ത	10	3	5
in the second	Dilution:	149	135	135	154	138	130	130	144	134	138
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
1,1-DCE	5 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
t-1,2-DCE	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 Ú	260 U	290 U	270 U	280 U
c-1,2-DCE	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Chloroform	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
1,1,1-TCA	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Trichloroethene	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Tetrachloroethene	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
1,3-DCB	2 μg/kg/250 μg/kg	NA	290 U	270 U	280 U						
1,4-DCB	2 μg/kg/250 μg/kg	NA	NA	NA	ŇA	NA	NA	NA	290 U	270 U	280 U
1,2-DCB	2 μg/kg/250 μg/kg	NA	290 U	270 U	280 U						
Benzene	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Toluene	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Chlorobenzene	2 μg/kg/250 μg/kg	300	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	280 U
Ethylbenzene	2 μg/kg/250 μg/kg	300 U	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	270
m/p-Xylene	4 μg/kg/540 μg/kg	600 U	540 U	540 U	620 U	550 U	520 U	520 U	580 U	540 U	1300
o-Xylene	2 μg/kg/250 μg/kg	530	270 U	270 U	310 U	280 U	260 U	260 U	290 U	270 U	670
Naphthalene	2 μg/kg/250 μg/kg	NA	290 U	860	2200 J						
TPH-DRO	100 mg/kg	NA	NA	NA	NA						
TPH-GRO	100 µg/kg	NA	NA	ŇA	NA						
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA						
TPH-IR (1996)	50 mg/kg	NA	150	260	62	150	52 U	52 U	58	9400 E	39000

Notes:

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E = Concentration exceeds the maximum reporting

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	ſ	AREA 3									
	Lab Sample ID:	57R-96-13X	57R-96-14X	57R-96-14X	57R-96-14X	57R-96-15X	57R-96-15X	57R-96-15X	57R-96-16X	57R-96-16X	57R-96-16X
	Date analyzed:	27-Aug-96	26-Aug-96	26-Aug-96	26-Aug-96	28-Aug-96	28-Aug-96	29-Aug-96	29-Aug-96	29-Aug-96	29-Aug-96
Survey and survey and	Depth (bgs):	9	3	5	9	3	5	9	3	3D	5
	Dilution:	166 .	136	161	160	268	675	780	131	131	141
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
1,1-DCE	5 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
t-1,2-DCE	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
c-1,2-DCE	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Chloroform	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1800 B	380 B	260 U	280 U
1,1,1-TCA	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Trichloroethene	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Tetrachloroethene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
1,3-DCB	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
1,4-DCB	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1600	2200	260 U	260 U	280 U
1,2-DCB	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	3700	6300	260 U	260 U	280 U
Benzene	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Toluene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Chlorobenzene	2 µg/kg/250 µg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	1600 U	260 U	260 U	280 U
Ethylbenzene	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	1400 U	2100	260 U	260 U	280 U
m/p-Xylene	4 μg/kg/540 μg/kg	660 U	540 U	640 U	640 U	1100 U	4400	9000	520 U	520 U	560 U
o-Xylene	2 μg/kg/250 μg/kg	330 U	270 U	320 U	320 U	540 U	2600	6700	260 U	260 U	280 U
Naphthalene	2 μg/kg/250 μg/kg	330 U	1200	320 U	320 U	2000	7100	12000 J	260 U	930 J	280 U
TPH-DRO	100 mg/kg	NA	NA	NA	' NA	NA	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA									
TPH-IR (1995)	50 mg/kg	NA									
TPH-IR (1996)	50 mg/kg	320	55	66 U	64	12000 E	12000 E	14000 E	53	53	57

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		AREA 3									
等成的时间 建成量量	Lab Sample ID:	57R-96-16X	57R-96-17X	57R-96-17X	57R-96-17X	57R-96-17X	57R-96-18X	57R-96-18X	57R-96-18X	57R-96-19X	57R-96-19X
	Date analyzed:	3-Sep-96	4-Sep-96	4-Sep-96	4-Sep-96	4-Sep-96	4-Sep-96	5-Sep-96	5-Sep-96	9-Sep-96	9-Sep-96
	Depth (bgs):	- 9	3	5	9	9D	3	5	- 9	3	5
	Dilution:	164	129	134	161	161	138	135	168	135	143
Analytes	Reporting Limit 1995/1996										
Vinyl Chloride	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,1-DCE	5 μg/kg/250 μg/kg	330 U	260 UJ	270 UJ	320 UJ	320 UJ	280 UJ	270 UJ	340 UJ	270 U	290 U
t-1,2-DCE	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
c-1,2-DCE	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Chloroform	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,1,1-TCA	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Carbon Tetrachloride	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Trichloroethene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Tetrachloroethene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,3-DCB	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,4-DCB	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
1,2-DCB	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Benzene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Toluene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Chlorobenzene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Ethylbenzene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
m/p-Xylene	4 μg/kg/540 μg/kg	660 U	520 U	540 U	_ 640 U	640 U	550 U	540 U	670 U	540 U	570 U
o-Xylene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
Naphthalene	2 μg/kg/250 μg/kg	330 U	260 U	270 U	320 U	320 U	280 U	270 U	340 U	270 U	290 U
TPH-DRO	100 mg/kg	NA									
TPH-GRO	100 μg/kg	NA									
TPH-IR (1995)	50 mg/kg	NA									
TPH-IR (1996)	50 mg/kg	66	52 U	54 U	65	64 U	55	54 U	67 U	150	54 U

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

				AREA 3		
	Lab Sample ID:	57R-96-19X	57R-96-20X	57R-96-20X	57R-96-20X	57R-96-20X
12-12-02-02-02-02-02-02-02-02-02-02-02-02-02	Date analyzed:	9-Sep-96	5-Sep-96	6-Sep-96	9-Sep-96	9-Sep-96
	Depth (bgs):	9	2	2D	6	10
	Dilution:	164	135	135	131	250
Analytes	Reporting Limit 1995/1996					
Vinyl Chloride	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
1,1-DCE	5 μg/kg/250 μg/kg	330 U	270 UJ	270 U	260 U	500 U
t-1,2-DCE	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
c-1,2-DCE	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
Chloroform	2 μg/kg/250 μg/kg	330 U	340	270 U	260 U	500 U
1,1,1-TCA	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Carbon Tetrachloride	2 µg/kg/250 µg/kg	330 U	270 U	270 U	260 U	500 U
Trichloroethene	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
Tetrachloroethene	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
1,3-DCB	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
1,4-DCB	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
1,2-DCB	2 μg/kg/250 μg/kg	510	270 U	270 U	260 U	500 U
Benzene	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
Toluene	2 µg/kg/250 µg/kg	370	270 U	270 U	260 U	500 U
Chlorobenzene	2 μg/kg/250 μg/kg	330 U	270 U	270 U	260 U	500 U
Ethylbenzene	2 μg/kg/250 μg/kg	670	270 U	270 U	260 U	500 U
m/p-Xylene	4 μg/kg/540 μg/kg	4500	540 U	540 U	520 U	1000 U
o-Xylene	2 μg/kg/250 μg/kg	1100	270 U	270 U	260 U	500 U
Naphthalene	2 μg/kg/250 μg/kg	1700	270 U	270 U	260 U	500 U
TPH-DRO	100 mg/kg	NA	NA	NA	NA	NA
TPH-GRO	100 µg/kg	NA	NA	NA	NA	NA
TPH-IR (1995)	50 mg/kg	NA	NA	NA	NA	NA
TPH-IR (1996)	50 mg/kg	700	54 U	54 U	52 U	200

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

									AREA 2							
Site ID:	The second second		57B-95-01)	X		57B-95-01X	NIGE STREET		57B-95-01X		000	57B-95-02X	14 - 14 - 14 - 14 - 14 - 14 - 14 - 14 -		57B-95-02X	
Field Sample Number:	and the second second	1.22	BX570100	No. Store and		BX570105			BX570121		1.5	BD570205			BX570200	10 Con
Lab Sample Number:	Devens	125026	DV4S*141		1.58	DV45*142	be was said		DV4S*143	Beer State	1.65	DV4S*441			DV4S*144	Street of the
Sample Date:	Background	Red to a	09/26/95			09/26/95	Sec. 28-00-0		09/26/95	17		09/27/95	- e - i		09/27/95	Same and
Depth:	Concentrations	1	0			· · · · 5			21	$\langle \cdot \rangle > 1$	1 ··· .	5	1.1.1		0	
Units:	µg/g		µg/g		100	μg/g			µg/g			μg/g	5 A. C		µg/g	
METALS																
Aluminum	18000		7530	IM	1	4620	IM		2210	IM		3050	D IM		7500	IM
Antimony	0.5	<	1.09		<	1.09		<	1.09		<	1.09	D	<	1.09	
Arsenic	19		15			9.66			4.61		ł –	8.93	D		19	
Barium	54		40.9			17.6			8.86			8.62	D		18.9	
Beryllium	0.81	<	.5		<	.5			.5		<	.5	D	<	.5	
Cadmium	1.28	<	.7		<	,7		<	.7		<	.7	D	<	.7	
Calcium	810		700			477			258			227	D		158	
Chromium	33		27			14		<	4.05			6.39	D		13	
Cobalt	4.7		4.9			3.79		<	1.42		1	1.83	D		6.15	
Copper	13.5		11.6			8.42			3.13		1	4.76	D	1	12.2	
Iron	18000		13300			8080		ł	4230			5970	D		13200	
Lead .	48		10			2.96			1.62		1	2.96	D		10	
Magnesium	\$500		3200			1930			893			1360	D	1	2560	
Manganese	380		240			187			70.4		1	86.4	D	1	481	
Nickel	14.6		19.5	sintle set		12			3.64			7.23	D		18.5	
Potassium	2400		1170			742			381		1	325	D	1	\$83	
Selenium		<	.25		<	.25		<	.25		k	.25	D	<	.25	
Silver	0.086	<	.589		<	.589		<	.589		<	.589	D	<	.589	
Sodium	131		299			309	<u></u>		. 347			245	D		260	8
Vanadium	32,3		15,5		1	8.5		<	3.39			4.9	D		11.1	
Zinc	43.9		26.4		1	19.8		<u> </u>	8.03		[13.6	D		25.8	
PESTICIDES/PCBS																
4,4'-ddc		<	.00765		<	.00765		1	.00765		<	.00765	D	<	.00765	
4.4'-ddt		<	.00707		<	.00707		<	.00707		<	.00707	D	<	.00707	
Aldrin		<	.00729		<	.00729		1<	.00729		<	.00729	D	<	.00729	
Chlordane - Alpha		<	.005	Т	1	.005	Т	<	.005	т	<	.005	TD	<	.005	Т
Dieldrin		<	.00629		1	.00629		·[<	.00629		<	.00629	D	<	.00629	
Endosulfan I		<	.00602		<	.00602		K	.00602		<	.00602	D	<	.00602	
Heptachlor Epoxide		<	.0062		<	.0062		1	.0062		<	.0062	D	<	.0062	
Pcb 1242		<	.082	Т	<	.082	Т	1	.082	т	<	.082	TD	<	.082	Т
Pcb 1248		<	.082	Т	<	.082	Т	1	.082	Т	<	.082	TD	<	.082	Т
Pcb 1260		<	.0804		<	.0804		<	.0804		<	.0804	D	<	.0804	
SVOCs					-,											
1,2,4-trichlorobenzene		<	.04		<	.04		1	.04		<	.04	D	<	.2	
1,2-dichlorobenzene		<	.11		<	.11		1	.11		<	.11	D	1	.6	
1.4-dichlorobenzene		<	.098		1	.098		1	.098		<	.098	D	<	.5	
2-methylnaphthalene			.43		<	.049		1	.049		<	.049	D	1	.4	
Acenaphthene		[.036		 <	.036		[.036		<	.036	D	<	.2	
Chrysene		۲ ۲	.12		15	.12		15	.12		<	.12	D	<	.6	
Dibenzoluran			.16		Ľ	.035		K	.035		<u>۲</u>	.035	D	1	.2	:
Fluoranthene		I.	.097		ľ.	.068		15	.068		1	.068	D	ľ.	.3	
Fluorene		۲ <u>۲</u>	.033		15	.033		1	.033		۲ <u>۲</u>	.033	D	1	.2	
Naphthalene		ł	.42		15	,037		1	.037		<u>۲</u>	.037	D		.4	
Phenanthrene		1	.28		15	.033		1	.033		۲.	.033	D	1	.2	
I Pyrene	1	1	.087		I< -	.033		1<	.033		1<	.033	D	1<	2	

PREMISING REPORT OF THE REPORT OF THE ADDRESS OF TH	NY WORKS NEW YORKS OF THE	ileft Oxiditional		wite velotiments	Attendants Mar.	and the second of the second burning		C. COLONI MARCEL								
Site ID:	and the state of the		57B-95-01X			57B-95-01X			57B-95-01X	с., Э.		57B-95-02X	8 16 1 . 1		57B-95-02X	
Field Sample Number:			8X570100	1984 B		BX570105	itter og som	- i	BX570121	- dia		BD570205	1. 10 A.		BX570200	
Lab Sample Number:	Devens	NAME:	DY45*141			DV45*142	1. S. S.	1.15	DV45*143		1.1	DV4S*441	server al a			
Sample Date:	Background	06.622	- 09/26/95	2.5000	SC223	09/26/95		Charles and	09/26/95		600	09/27/95		<u>, 1</u>	09/27/95	
Depth:	Concentrations	200	D Shares Shares		18185	5		1000	21 -	12000		5	No seco		0	10 10 10 10 10 10 10 10 10 10 10 10 10 1
Units:	H#/R	22.232	µø/g			hø/e			<u></u>				- an awa	<u></u>		an chidra a
Bis(2-ethylhexyl) Phthalate			2.7		<	.62		<	.62		<	.62	D	<	3	
Di-n-butyl Phthalate	1	<	.061		<	.061		<	.061		<	.061	D	<	.3	
TPH BY GC		·														
TPH MOTOR OIL PATTERN			NA			NA			NA			NA			NA	
VOCs																
*1,2-dichloroethylenes (cis And Trans)		<	.003		<	.003		<	.003		<	.003	D	<	.003	
2-hexanone	-	<	.032		<	.032		<	.032		<	.032	D	<	.032	
Acetone]	<	.017		<	.017		<	.017		<	.017	D	<	.017	
Chloroform			.00089		<	.00087		<	.00087		<	.00087	D	<	.00087	
Dichloromethane		<	.012		<	.012		<	.012		<	.012	D	<	.012	
Ethylbenzene		<	.0017	1	<	.0017		<	.0017		<	.0017	D	<	.0017	
Tetrachloroethene		<	.00081		<	.00081		<	.00081		<	.00081	D	<	.00081	
Toluene		<	.00078		<	.00078		<	.00078		<	.00078	Ð		.0016	
Trichloroethylene		<	.0028		<	.0028		<	.0028		<	.0028	D	<	.0028	
Trichlorofluoromethane			.017			.013			.014	- 1	<	.0059	D	<	.0059	
Xylenes		<	.0015		<	.0015		<	.0015		<	.0015	D	<	.0015	
OTHER																
Total Organic Carbon								<u> </u>								
Total Petroleum Hydrocarbons			81.3			26.4			44.6			138	D		7970	
		NOTE	S:													

FLC = USAEC Flagging Code

DQ = Data Qualifier

<= Concentration was less than the certified reporting limit

D = Duplicate Sample

T = Non-target compound analyzed for and not detected (non-GC/MS method) I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or techniqueZ = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated = Exceeds established Devens background levels NA = Not Analyzed

.

								AREA 2							
Site ID:	NEW BRIEF	57B-95-0	2X	57B-9	-02X		5	7B-95-03X			57B-95-04X			57B-95-05X	
Field Sample Number:	AGE STATISTICS	BX5702	05	BX57	0217	1. 2	Caterra	3X570319		300 S 34	BX570415		1000	BX570515	
Lab Sample Number:	. Devens	DV4S*1	45	DV4S	*146			DV45*147		1000	DV4S*150		5-34 Z 2	DV4S*151	and a second
Sample Date:	Background	09/27/9	5	09/2	/95		0.020	09/27/95			09/28/95	1.0		09/28/95	
Depth:	Concentrations	5		1 I.				19			15	Stand Street		15	and in the second
Units:	<u>esta hekenta</u>	μg/g		and the second second he	R	18,605	SPACE NO.	νμg/g		STREET,	μ <u>μ</u> /g		SSUCCES.	у дү	1.1.2. (1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1
Aluminum	18000	7800	the state of the s		0	114		2220	71.5		2600		·		
Antimony	10000	100	1141	24	0	IN	-	1.00	11/1		2300	SM.		2910	IM
Amenio	0.3	1.09			9 E			6.09		۲ ۲	1.09		<	1.09	
Parium	19	9.0		0.1				5.75			8.1			10.6	
Darium	34	11.1			3			0.91			10.7		5	5.18	
Cadarium	1.70						2			Ľ.			5	.5	
Cathlen	1,40	1 164		`				.1		<	./		<	.7	
Catchin	210	204		20	a r			319		L	276			325	
Cabalt		0.30		4.0	2		2	4.05		2	4.05		<	4.05	
Cooner	4.1	2.34		1.4	4		`	1.42		۲.	1.42		<	1.42	
Tron	12.5	7100		3.1	4			4.33			3.93			3.9	
Land	10000	276		10	0			4490			4360			2280	
Magnashum	5500	1 2.70		1.5	0			3.93			2.09			1.72	
Managere	380	118		97	1			70 1			903			76.0	
Nietel	14.6	835		51	6			4.2			135			10.2	
Potassium	2400	509		33	1	1		310			573			4.00	
Selenium		< .25		< .2	i		<	25		<	75		e	215	
Silver	0.086	< 589		< 58	, Q		2	580		2	580			580	
Spdium	131	263	100 50	NO 0031			N/SOM	297	3 2	10000	373	S 1	Presso	304	515.H
Vanadium	32.3	6.49	and an	< 3.3	9 9		<	3 30	ojioni	<	1 30	30.M	10016-0132	2 10	
Zinc	43.9	16.5		< 8.0	3		<	8.03		2	8.03		2	8.03	
PESTICIDES/PCBS											0.00		· · · ·		
4,4'-ddc		< .00765		< .007	65	T	<	.00765		<	.00765		<	.00765	
4.4'-ddi		< .00707		< .007	07		<	.00707		<	.00707		<	00707	
Aldrin		< .00729		< .007	29	1	<	.00729		<	.00729		<	.00729	
Chlordane - Alpha		< .005	Т	< .00	5 Т		<	.005	т	<	.005	т	<	.005	т
Dieldrin		< .00629		< .006	29		<	,00629		<	.00629		<	.00629	-
Endosulfan I		< ,00602		< .006	02		<	.00602		<	.00602		<	.00602	
Heptachlor Epoxide		< .0062		< .00	i2		<	.0062		<	.0062		<	.0062	
Pcb 1242		< .082	т	< .08	2 Т		<	.082	Т	<	.082	т	<	.082	т
Pcb 1248		< .082	Т	< .08	2 Т		<	.082	т	<	.082	т	<	.082	т
Pcb 1260		< .0804		< .080)4		<	.0804		<	.0804		<	.0804	
SVOCs															
1,2,4-trichlorobenzene		< .04		< .04	l .		<	.04		<	.04		<	.04	
1,2-dichlorobenzene		< .11		< .11			<	.11		<	.11		<	.11	
1,4-dichlorobenzene		< .098		< .09	8		<	.098		<	.098		<	.098	
2-methylnaphthalene		< .049		< .04	9	1	<	.049		<	.049		<	.049	
Acenaphthene		< .036		< .03	6		<	.036		<	.036		<	.036	
Chrysene		< .12		< .I	_		<	.12		<	.12		<	.12	
Dibenzofuran		< .035		< .03	5		<	.035		<	.035		<	.035	
Fluoranthene		< .068		< .06	8		<	.068		<	.068		<	.068	
Fluorene		< .033		< .03	3		<	.033		<	.033		<	.033	
Naphthalene		< .037		< .03	7		<	.037		<	.037		<	.037	1
Phenanthrene		< .033		o3 (03	3		<	.033		<	.033		<	.033	1
Pyrene		.033		1< .03	3		<	.033		<	033		<	033	

Site ID;	100 100 100	57B-95-02X	Carlos Carlos	57B-95-02X		57B-95-03X		57B-95-04X		57B-95-05X	
Field Sample Number:		BX570205	and the second	BX570217		BX570319		BX570415	10	BX570515	
Lab Sample Number:	Devens	DV4S*145	Second second	DV4S*146	1000	DV4S*147		DV4S*150		DV4S*151	2.5 Store 10.5
Sample Date:	Background	09/27/95		09/27/95		09/27/95		09/28/95	1997 - See - S	09/28/95	
Depth:	Concentrations	5		17	1	- 19		15		15	
Units:	HR/R	Hg/g		µg/g		µg/g		HE/E		μg/g	
Bis(2-cthylhexyl) Phthalate		< .62	<	.62	<	.62	<	.62	<	.62	
Di-n-butyl Phthalate		< .061	<	.061	<	.061	<	.061	<	.061	
TPH BY GC											
TPH MOTOR OIL PATTERN											
VOCs											
*1,2-dichloroethylenes (cis And Trans)		< .003	<	,003	<	.003	<	.003	<	.003	
2-hexanone		< .032	<	.032	<	.032	<	.032	<	.032	
Acetone		< ,017	<	.017	<	.017	<	.017		.025	
Chloroform		< .00087	<	.00087	<	.00087	<	.00087	<	.00087	
Dichloromethane		< .012		.049		.019		.033	<	.012	
Ethylbenzene		< .0017	<	.0017	<	.0017	<	.0017	<	.0017	
Tetrachloroethene		< .00081	<	.00081	<	.00081	<	.00081	<	.00081	
Toluene		< .00078		.0014	l l	.0045	<	.00078		.0037	
Trichloroethylene		< .0028	<	.0028	<	.0028	<	.0028	<	.0028	
Trichlorofluoromethane		< .0059	<	.0059	<	.0059	<	.0059		.0068	-
Xylenes		< .0015	<	.0015	<	.0015	<	.0015	<	.0015	
OTHER	_								I		
Total Organic Carbon											
Total Petroleum Hydrocarbons		87	<	27.6		52.7	<	27.8	<	27.6	

NOTES:

FLC == USAEC Flagging Code

DQ = Data Qualifier

< = Concentration was less than the certified reporting limit

 $T = \mbox{Non-target compound analyzed for and not detected (non-GC/MS method)} \\ I = \mbox{Interferences in the sample caused the quantitation and/or identification to be suspect}$

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyzed for and detected by non-GC/MS method

J = Value is estimated = Exceeds established Devens background levels

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TABLE 7-12 RI SOIL OFF-SITE ANALYTICAL RESULTS AOC 57 REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

.					A	REA 2					
Site ID: Field Sample Number: Lab Sample Number: Sample Data:	Devens	57B-95 BX570 DV4S*	06X 612 152	57E-95-0 EX5701 DV4S*1	1X 06 01		57E-95-02X EX570200 DV4S*102			57E-95-04X ED570405 DV4S*436	
Dearth:	Contembration	17	33	09/18/9	and a second second	0.00	09/18/95	d the	1.68	09/19/95	and the second
Tulter	Concenti Ations	12		· · · · · · · · · · · · · · · · · · ·					1.20	2	12.03157
METALS	Construction by Construction	1 as the factor of the factor	C. B. A.C. OLANGERSON STRAND	<u> </u>	Terterial American School	< 1974.002.8686	and Phy B weeks		11. 1955 60534	h h h h h h h h h h h h	A STATE AND A STATE OF
Aluminum	18000	286) IM	2.590			3920		- 	2730	n
Antimony	0.5	< 1.05		< 1.09		<	1.09		2	1.00	D
Arsenic	19	7.45		9.87		[9.73		T.	10.7	D D
Barium	54	11.5		7.05			32.1			113	Ď
Beryllium	0.81	< .5		< .5		<	S		<	5	Ď
Cadmium	1.28	< .7		< 7		<	7		2	7	Ď
Calcium	810	384		400		-	580		1	176	D D
Chromium	33	< 4.05		< 4.05			8.94		<	4.05	Ď
Cobalt	4.7	2.25		2.73			2.76		1	1.82	ň
Copper	13.5	4.4		4.14			11.6			3.26	ñ
Iron	18000	5420)	4640			8420			4550	ñ
Lead	48	1.8		2.02			22.9			1.81	Ď
Magnesium	5500	1040)	773			1140			848	D
Manganese	380	79.4		68.1			79.2			226	ñ
Nickel	14.6	5,99		5.55			8.5			5.15	ñ
Potassium	2400	422		356			427			428	D
Selenium		< .25		< .25			.883		<	.25	D
Silver	0.086	< .589		< .589		<	.589	PEDAIR	<	.589	D
Sodium	131	328		185	S		436			286	D
Vanadium	32.3	4.66		< 3.39			11.1		-	4.37	D
Zinc	43.9	11.6		< 8.03			17.2			10	D
PESTICIDES/PCBS											
4,4'-dde		< .0076	\$	< .00765			.0199	Ċ	<	.00765	D
4,4'-ddt		< .0070	7	< .00707			.0257	С	<	.00707	D
Aldrin		< .0072	9	< .00729		<	.00729		<	.00729	D
Chlordane - Alpha		< .005	Т	< .005	Т	<	.005	т	<	.005	TD
Dieldrin		< .0062	9	< .00629		<	.00629		<	.00629	D
Endosulfan I		< .0060	2	< .00602		<	.00602		<	.00602	D
Heptachlor Epoxide		< .0063		< .0062		<	.0062		<	.0062	D
Pcb 1242		< .082	T	< .082	Т	<	.082	Т	<	.082	TD
Pcb 1248		< .082	Т	< .082	Т	<	.082	Т	<	.082	TD
Pcb 1260		< .080-		< .0804		<	.0804		<	.0804	D
SVOCs						1					
1,2,4-trichlorobenzene		< .04		< .04		<	.2		<	.04	D
1.2-dichlorobenzene				< .11		<	.6		<	.11	D
1.4-dichlorobenzene		< .098		800, >		<	.5		<	.098	Ð
2-methyinaphthalene		< .049		< .049		<	.2		<	.049	D
Acenaphthene		\$.036		< .036		15	.2		<	.036	D
Dihanan		.12		.12		Ľ	.6		15	.12	D
Diocizoiuran		.035		.035		5	.2		5	.035	D
Filoren		.068		.068		2	<i>Е.</i>		15	.068	D
Manhabalana		.033		.033			.2		5	.033	D
Phagaptheona		.03/		.037		<u>`</u>	.2		5	.037	D
Burena		.033		.033			-4		ľ.	.033	D
Fricis		<u>~ .033</u>		.033		1	.4		1<	.033	D

Site ID: Field Sample Number: Lab Sample Number: Sample Date: Depth: Depth:	Devens Background Concentrations		57B-95-06X BX570612 DV45*152 09/28/95 12		57E-95-01X EX570106 DV4S*101 09/18/95 0		57E-95-02X EX570200 DV45*102 09/18/95 0		57E-95-04X ED570405 DV4S*436 09/19/95 5	
Bis(2-ethylheryl) Phthalate	PRE	<	62	14 (2022) - C	62		<u>PR/2</u>			6
Di-n-butyl Phthalate		2	061	2	061		3		.02	D D
TPH BY GC		-				1.			.001	<u> </u>
TPH MOTOR OIL PATTERN	1	·		1	NA		NA		NA	
VOCs	·									
*1,2-dichloroethylenes (cis And Trans)		<	.003	<	,003	<	.003	<	.003	D
2-hexanone		<	.032	<	.032	<	.032	<	.032	а
Acetone		<	.017	<	.017	<	.017	<	.017	D
Chloroform		<	.00087	<	.00087	<	.00087	<	.00087	D
Dichloromethane		<	.012	<	.012	<	.012	<	.012	D
Ethylbenzene		<	.0017	<	.0017		.0024	<	.0017	D
Tetrachloroethene		<	.00081	<	.00081	<	.00081	<	.00081	D
Toluene		<	.00078	<	.00078		.0025	<	.00078	D
Trichloroethylene		<	.0028	<	.0028	<	.0028	<	.0028	D
Trichlorofluoromethane			.008	1	.0057	<	.0059	<	.0059	D
Xylenes		<	.0015	<	.0015		.029	<	.0015	D
OTHER										
Total Organic Carbon								-		
Total Petroleum Hydrocarbons		<	27.6		141		454		23.6	D

NOTES: FLC = USAEC Flagging Code

DQ = Data Qualifier

< = Concentration was less than the certified reporting limit

 $T \approx$ Non-target compound analyzed for and not detected (non-GC/MS method) I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated

								AREA	2			•			
Site ID;	A Sectored as	57E-95-042	C	57E-9	5-05X	1 : 1 : 1 : : :	and the second	57E-95-07X			57E-95-08X			57E-95-09X	
Field Sample Nuniber:	2010/02/2010/2010	EX570405	and the second second	EX5	70506		1000	EX570704			EX570804		[]	EX570905	
Lab Sample Number:	Devens 🔐	DV4S*104	1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	DV4	\$*105	El estado	Sec.	DV45*107	200 C		DV4S*108			DV4S*109	1999 - 1999 -
Sample Date:	Background	09/19/95		09/1	9/95	22.500		09/19/95			09/20/95			09/20/95	
Depth:	Concentrations	5			S		1.1	- 4			- 4			- 5	
Units:	μ8∕Σ	µg/g	1993 - CALSSIN	н	/r		507868	PR/8			<u>ре/е</u>	166 (150 (1996)).(j	8 (Q1625	Pg/g	
METALS							<u> </u>								
Alununum	18000	2750		47	20			4810			3990		1.	2700	
Animony	0.5	< 1.09		< 1.			<	1.09		<	1.09		<	1.09	
Arsenic	19	9.68			1			3.5			11		1	4.38	
i Barium	34	10.2		1.	.2		1.	34.7			52.9			17.1	
Beryllum	0.81	< .5		< . ا	5		<	.5		<	.5		<	.5	
Caemium	1.28			<u> </u>	/		10000000	exercise and the second se	1111	<	.7		<	.7	
Calcium	810	205			25			1190	22		746		Ι.	610	
Chromaum	33	4.05			.2		<	4.05		<	4.05		<	4.05	
Cobalt	4./	1.0/		3.	87			2.61		<	1.42		<	1.42	
Copper	13.3	3.33		1.	4y 00			8.13			4.41			1,97	
uron	18000	4300		/0	80 (2			2410		TANK TRANSPORT	238U	the second		1980	
Lead	48	1.83		4.	02 70		1	34.0		22542	188			6.87	
Magnesium	5500	890		10	70			518			243			185	
Manganese	380	251						1/5			25.5			18.7	
INICKCI Data	14.0	3,03		9.	24			3.48			4.19		<	1.71	
Polassium Selectum	2400	244			10 HC		NUMBER OF	130	W .1	87755	208	50 K	Entropy	197	
Stichum	0.0%6	550			20		Course of the	-045 590			590				
Sulver	0.080	202.			C SALESSED		-	486.	100 M	EXSTRACT	.289	100 A	< 652845	.289	
Vanadium	22 2	2 77		5.52 (min. 2.7)	07		2/382/355	2 20	1963 1963	Protection of	0.70			4/0	
Zinc	410	9.76		a. 14	0		`	304		KARA	9.19		\geq	3.39	
PESTICIDES/PCBS	45.5	2.76		·				20.4		CC (8025500)	1997 PLACE VILLE	2009999	<u> </u>	8.05	
4 4'-dde		< .00765		< .00	765		<	00765		<	00765		1<	00765	
4.4'-ddt		< .00707		< .00	707		<	.00707		<	.00707		<	00707	
Aldrin		< .00729		< .00	729		<	00729		<	00729		~	00729	
Chlordane - Alpha		< .005	т	< .0	05	т	<	.005	т	<	.005	т	<	005	т
Dieldrin		< .00629	-	< .00	529	-	<	.00629	-	<	.00629	•	<	.00629	•
Endosulfan I		< .00602		< .00	502		<	.00602		<	00602		<	00602	
Heptachlor Epoxide		< .0062		< .00	62		<	.0062		<	.0062		<	.0062	
Pcb 1242		< .082	т	< .0	82 ·	т	<	.082	т	<	.082	т	<	.082	т
Pcb 1248		< .082	т	< .0	82 ·	т	<	.082	т	<	.082	т	<	.082	Ť
Pcb 1260		< .0804		< .08	04		<	.0804		<	.0804		<	.0804	•
SVOCs							•								
1,2,4-trichlorobenzene		< .04			4		<	.4		<	.04		<	.2	
1,2-dichlorobenzene		< .11		<	1		<	1		<	.11		<	.6	
1.4-dichlorobenzene		< .098		< .0	98		<	1		<	.098		<	.5	
2-methylnapinthalene		< .049		< .0.	49			6		<	.049		<	.2	
Acenaphthene		< .036		< .0.	36		<	.4		<	.036		<	.2	
Chrysene		< .12		< .t	2		<	1		<	.12		<	.6	
Dibenzofuran		< .035		< .0.	35		<	.4		<	.035		<	.2	
Fluoranthene		< .068		0, >	58		<	.7		<	.068		1	.7	
Fluorene		< .033		< .0.	33		<	.3		<	.033		<	.2	
Naphthalene		< .037		< .0.	37			6		<	.037		<	.2	
Phenanthrene		< ,033		< .0,	33		<	.3		<	.033		ł	.3	
Pyrene		< .033		< .0.	33		<	.3		<	.033		1	.6	

Site ID:		57E-95-04X		57E-95-05X		57E-95-07X	305 C	57E-95-08X		S7E-95-09X
Field Sample Number:	ACC AND A DESCRIPTION	EX570405		EX\$70506		EX570704	1. See 1. See	EX570804		EX570905
Lab Sample Number:	Devens	DV4S*104		DV45*105	$= D^{-1}D^{-1}$	DV4S*107		DV4S*108		DV4S*109
Sample Date:	Background	09/19/95		09/19/95	Sec. acr	09/19/95	1.1	09/20/95		09/20/95
Depth:	Concentrations	5		6 .	1 m.	4		4		5
Units:	µr/r	μg/g		P/g	1.000	₽ø/g		hë/e	04.33	ue/e
Bis(2-ethylhexyl) Phthalate		< .62	<	.62	<	6	<	.62	<	3
Di-n-butyl Phthalate		< .061	<	.061	<	.6	<	.061	<	.3
TPH BY GC									•	
TPH MOTOR OIL PATTERN		NA		NA		NA		NA		NA
VOCs										
*1,2-dichloroethylenes (cis And Trans)		< ,003	<	.003	1	,0039	<	.003	<	.003
2-hexanone		< .032	<	.032	<	.032	<	.032	<	.032
Acetone		< .017	<	.017	<	.017	<	.017	<	.017
Chloroform		< .00087	<	.00087	<	.00087	<	.00087	<	.00087
Dichloromethane		< .012	<	.012	<	.012	<	.012	<	.012
Ethylbenzene		< .0017	<	.0017		.051	<	.0017	<	.0017
Tetrachloroethene		< .00081	<	.00081		.0059	<	.00081	<	,00081
Toluene		< .00078	<	.00078		.023	<	.00078	<	.00078
Trichloroethylene		< .0028	<	.0028		.011	<	.0028	<	.0028
Trichlorofluoromethane		.0083		.007	<	.0059	<	.0059	<	.0059
Xylenes		< .0015	<	.0015		.27	<	.0015	<	.0015
OTHER										
Total Organic Carbon					1					
Total Petroleum Hydrocarbons		< 27.6	<	20.7		31800		57.6		79.2
		NOTES:								· · · ·

FLC = USAEC Flagging Code

DQ = Data Qualifier

<= Concentration was less than the certified reporting limit</p>

T = Non-target compound analyzed for and not detected (non-GC/MS method) I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or techniqueZ = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated = Exceeds established Devens background levels

						ARE/	12				
Site ID:		57E-95-10X		57E-95-12X	See Sec.	57E-95-13X		57E-95-14X		57E-95-15	K
Field Sample Number:		EX571000		EX571200		EX571305	e positive posi-	EX571406		EX571502	o the full search of the second
. Lab Sample Number:	Devens	DV4S*110	e	DV4S*112		DV4S*113		DV4S*114		DV4S*115	Contraction of the second
Sample Date:	Background	09/19/95	1997 - 1997 1997 - 1997 - 1997 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1	09/20/95		09/21/95		09/21/95		09/21/95	- 10 A. 10 A.
Depth:	Concentrations	Ö	al and the	0	40 a 40 a	5	e de la ser a	6		2	-
Units:	µg/g	µg/g		pg/g	and the second second	μg/g		~µg/g	Contraction of the		No. of the second s
METALS											in the second se
Aluminum	18000	7100		6180		4630		2960		9720	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Antimony	0.5	< 1.09		< 1.09		< 1.09		< 1.09		< 1,09	
Arsenic	19	7.86		9.54		21		18		2.14	
Barium	54	18.8		25.9		22.1		< 5.18		37.1	
Beryllium	0.81	.705		< .5		< .5		< .5		< 5	
Cadmium	1.28	< .7		< .7		< .7		< .7		< 7	
Calcium	810	134		255		846		261		595	
Chromium	33	7.69		13.6		2410		< 4.05		10.4	
Cobalt	4.7	1.86		1.93		4.7		2.43		< 1.42	
Copper	13.5	4.14		12.4		5.7		4,51		9.36	
Iron	18000	7030		7920		6690		5940		4910	
Lead	48	8.05		225	6.4	5060		2.26		76.2	F778133
Magnesium	5500	926		1150		1400		1020		808	
Manganese	380	274		97.2		76.5		66.8		51.9	
Nickel	14.6	6.61		7.35		6.3		6.16		5.78	
Potassium	2400	144		327		309		386		300	
Selenium		< .25		< .25		< ,25		< .25		.569	
Silver	0.086	< .589		< .589		< .589		< .589		< .589	
Sodium	131	337		446		335	92A	410		725	235
Vanadium	32.3	7,58		14		7.6		< 3.39		11.9	
Zinc	43.9	13,7		22.7		753	386 J	< 8.03		42,9	
PESTICIDES/PCBS											
4,4'-ddc		< .00765		< .00765		< .00765		< .00765		< .00765	
4,4'-ddt		< .00707		< .00707		< .00707		< .00707		< .00707	
Aldrin		< .00729		< .00729		< .00729		< .00729		< .00729	
Chlordane - Alpha		< .005	Т	< .005	Т	< .005	Т	< .005	т	< .005	т
Diekfrin		< .00629		.0192	с	< .00629		< .00629		.0115	С
Endosulfan I		< .00602		< .00602		< .00602		< .00602		< .00602	
Heptachlor Epoxide		< .0062		< .0062	_	< .0062	-	< .0062		< .0062	
Pcb 1242		< .082	T	< .082	T	< .082	Т	< .082	Т	< .082	Т
Pcb 1248		< .082	Т	< .082	т	< .082	т	< .082	Т	< .082	т
Pcb 1260		< .0804		4.Z	<u> </u>	< .0804		< .0804		7.3	C
SVOCs			,				-				
1,2,4-trichlorobenzene		< .04		< 4		< .04		< .04		8. >	
1,2-dichlorobenzene		< .11		< 1		< .11		< .11		< 2	
1,4-dichlorobenzene		< .098		< 1		< .098		< .098		< 2	
2-methylnaphthalene		< ,049		< .5		< .049		< .049		< 1	
Acenaphthene		< .036		< 4		< .036		< .036		< .7	
Chrysene		< .12		< 1		< .12		< .12		< 2	
Dibenzoluran		< .035		< .4		< .035		< .035		< .7	
riuorantaene		.11		S .7		< .068		< .068		< 1	
Fluorene		< .033		s .3		< .033		< .033		< .7	
Raphinaiche		< .037		< .4		< .037		< .037		< .7	
Phenanthrene	-	.045		< .3		< .033		< .033		< .7	
Pyrene		. 12		< .3		I< .033		< 033		1< 7	

Site ID:		57E-95-10X		57E-95-12X	1949 B.	57E-95-13X		57E-95-14X		57E-95-15X	
Field Sample Number:	-3005039M22	EX571000		EX571200		EX571305	100 C	· EX571406		EX571502	12.00
Lab Sample Number:	Devens	DV4S*110	37.5 C	DV4S*112		DV4S*113	1000	DV4S*114		DV45*115	
Sample Date:	Background	09/19/95		09/20/95		09/21/95		09/21/95		09/21/95	
Depth:	Concentrations	0		0	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	5	1. Sec. 1.	6	1. N. S.	2	
Units:	µg/g	µg/g		μe/g	50 A	µg/g	Acres 64	μg/e		uz/e	
Bis(2-ethylhexyl) Phthalate		< .62	<	6	<	.62	<	.62	<	10	
Di-n-butyl Phthalate		< .061	<	.6	<	.061	<	.061	<	1	
TPH BY GC											
TPH MOTOR OIL PATTERN		NA		NA	1	NA		NA		NA	
VOCs											
*1,2-dichloroethylenes (cis And Trans)		< .003	<	.003	<	.003	<	.003	<	.003	
2-hexanone		< .032	<	.032	<	,032	<	.032	<	.032	
Acetone		< .017	<	.017	<	.017		.037	<	.017	
Chloroform		< .00087	<	.00087	<	.00087	<	.00087	<	.00087	
Dichloromethane		< .012	<	.012	<	.012	<	.012	<	.012	
Ethylbenzene		< .0017	<	.0017	<	.0017		.0017	<	.0017	
Tetrachloroethene		.003		.0011	<	.00081	<	.00081		.0023	1
Toluene		.0037	1	.0083	<	.00078	<	.00078		.0017	- 1
Trichloroethylene		< .0028	<	.0028	<	.0028	<	.0028	<	.0028	
Trichlorofluoromethane		.0074	1	.0073	<	.0059	<	.0059	<	.0059	
Xylenes		< .0015	<	,0015	<	.0015	<	.0015	<	.0015	
OTHER											
Total Organic Carbon					1						
Total Petroleum Hydrocarbons		25		5110	<	27.6		49.3		26100	
		N	DTES:								

FLC = USAEC Flagging Code

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< = Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)

I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

.

C = Analysis was confirmed by a different column or technique

Z = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated

Exceeds established Devens background levels

.

							AREA	2						
Site ID:		57E-95-1	.6X	57E-95-16	x		57E-95-17X			57E-95-18X			57E-95-19X	
Pielo Sample Number;	STRUCTURE AND	EAS/10	00 31	EX5/100.	and the second second		EX5/1/00			EX571802	1.1.1.1.1.1.1.1.1		EX571902	and the second second
Lao Sample Number:	Devens	DV45*1		DV45-11	o 1 1 1 1 1	0.55	DY45*117		1.00	DV45*118		4	DV45*119	
Danilu	Canceptound	09/209	9	09/11/95	100 00 00 00 00 00 00 00 00 00 00 00 00	1000	.09/2095	1.00	in the late	09/21/95		1.20	09/21/95	4 4 6 6 6 6
Units:	uz/z	ur/r		ur/r			u ue/e	e en		4 119/9			4	
METALS						1.000			Crowney and	dente Frankrigen		200 1 2 1 1 1 1 1 1 1	Company Per Family	Contraction of the second second
Aluminum	18000	3140	IM	4430			5460			9940		1	3530	
Antimony	0.5	< 1.09		< 1.09			1.62		<	1.09		<	1.09	
Arsenic	19	7.06		12,7			9.06			10.6			1.71	
Barium	54	13.6		116	1977 S 1		37.5		<	5.18		<	5.18	
Beryllium	0.81	< .5		< .5			.708		<	.5		<	.5	
Cadmium	1.28	< .7		< .7		<	.7		<	.7		<	.7	
Calcium	810	414		659			528		<	100		<	100	
Chromium	33	8,96		35.6			15.4			8.94		<	4.05	
Cobalt	4.7	2.09		< 1.42			2.31		<	1.42		<	1.42	
Copper	13.5	6.72		17.6			14.4 •	23		2.87		<	.965	
Iron	18000	5390		6880		02.000	7190			6370			762	
Lead	48	40.5		224			110	900 H		4.62			4.15	
Magnesium	5500	1120		633			1390			739		<	100	
Manganese	380	74.9		72.7			138			34.8			3.95	
Nickel	14.6	6.09		5.76		1	10.4			6.12		<	1.71	
Potassium	2400	345		257			460			197		<	100	
Selenium		< .25		1.1	20222	E ST	.449		<	.25			.652	
Silver	0.086	< .589		.959		<	.589		<	.589		<	.589	
Sodium	131	294		661		127	346			404	1	100	560	5. C. S.
Vanadium	32.3	5.65		9.58			12.5			10.1		<	3.39	
Zinc	43.9	23.2		66.7			41		<	8.03		<	8.03	
PESTICIDES/PCBS														
4,4'-dde		< .00765	i	< .00765			.00928	С	<	.00765		<	.00765	
4.4'-ddt		< .00707		< .00707		<	.00707		<	.00707		<	.00707	
Aldrin		< .00729	1	< .00729		<	.00729		<	.00729		<	.00729	
Chlordane - Alpha		< .005	Т	< .005	Т	<	.005	Т	<	.005	Т	<	.005	Т
Dieldrin		.0127	¢	< .00629			.032	с	<	.00629		<	,00629	
Endosulfan 1		< .00602		.081	с	<	.00602		<	.00602		<	.00602	
Heptachlor Epoxide		< .0062		< .0062		<	.0062		<	.0062		<	.0062	
Pcb 1242		< .082	т	< .082	т	<	.082	т	<	.082	т	<	.082	т
Pcb 1248		< .082	т	3.2	CZ	<	.082	Т	<	.082	т	<	.082	т
Pcb 1260	L	.188	С	12	<u>C</u>		.342	с	<	.0804		<	.0804	
SVOCs							· · · · · .							
1,2,4-trichlorobenzene		< .2		< <u>2</u>		<	.4		<	.04		<	.04	
1,2-dichlorobenzene		< .0		< 4		<	1		<	.11		<	-11	
1,4-dichlorobenzene		< .5		< 4		<	1		<	.098		<	.098	
2-methyinaphthaiene		< .2		< 2		<	.5		<	.049		<	.049	
Acenapathene		< .2				5	.4		<	.036		<	.036	
Chrysene		< .0		< >		<	1		<	.12		<	.12	
Dibenzoluran		< .2 - 2				<	.4		<	.035		<	.035	
Fluorenc		<u>د.</u> <				-	1		2	.008		Ľ.	.068	
Mandatalana		2 .2					.3		2	.033		Ľ.	.033	
Physical Control of Con						<u>`</u>	.4		2	.037		Ľ	.037	
I ACREADING CHE							.u.		D	.033		Ľ	.033	
44 11646	•	l∼		1 - 1		1			1 >	.033		15	.015	

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DEVENS, MASSACHUSETTS

Site ID:		57E-95-16X		57E-95-16X		57E-95-17X		57E-95-18X		57E-95-19X	
Lab Sample Number	Damane	EX3/1000		DV4C+116		EX3/1/00		EA5/1802	and the second second	EX571902 :	
Sample Data:	Background	09/21/95		00/11/05		00/01/06		DV45-118		. DV45-119	
Deaths	Canadata	03/2/1/55	1944 A. C. A.	03121135		. 0500155		09120195	1. A.	09/21/95	
Units;	Length Le	με/g		μg/e		μ <u>ε/</u> ε	Supplement in the	2 ug/g		2 119/19	
Bis(2-ethylhexyl) Phthalate		< 3	<	20	<	6	<	.62	<	.62	
Di-n-butyl Phthalate		< .3	<	2		2	<	.061	<	.061	
TPH BY GC									······		
TPH MOTOR OIL PATTERN		NA		NA		NA	1	NA		NA	
VOCs											
*1,2-dichloroethylenes (cis And Trans)		< .003	<	.003	<	.003	<	.003	<	.003	
2-hexanone		< .032	<	.032	<	.032	<	.032	<	.032	
Acetone		< .017		.067	<	.017		.03		.034	
Chloroform		< .00087	<	.00087	<	.00087	<	.00087	<	.00087	
Dichloromethane		< .012	<	.012		.015	<	.012	<	.012	
Ethylbenzene		< .0017		.0058	<	.0017	<	.0017	<	.0017	
Tetrachloroethene		< .00081	<	.00081		.0047	<	.00081	<	.00081	
Toluene		< .00078		.011		.0072	<	.00078	<	.00078	
Trichloroethylene		< .0028	<	.0028	<	.0028	<	.0028	<	.0028	
Trichlorofluoromethane		.0084	<	.0059		.014	<	.0059	<	,0059	
Xylenes		< .0015	<	.0015	<	.0015	<	.0015	<	.0015	
OTHER									•		
Total Organic Carbon			[1		
Total Petroleum Hydrocarbons		169		30000		2390		49.5		130	

NOTES:

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 $T = Non-target compound analyzed for and not detected (non-GC/MS method) \\ I = Interferences in the sample caused the quantitation and/or identification to be suspect$

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or techniqueZ = Non-target analyte analyze for and detected by non-GC/MS method

J = Value is estimated

= Exceeds established Devens background levels
	AREA 2				AREA 3									
Site.ID: Field Sample Number: Lab Sample Number: Sample Date:	Devens Background	57E-95-20 EX57200 DV4S*12 09/21/95	X 5 . 0	57B-96-07 BX57070 DV4S*52 08/28/96	X 0 0		57B-96-07X BX570705 DV4S*521 08/28/96		5	7B-96-08X BX570800 DV4S*522 08/29/96			57B-96-08X BX570805 DV4S*523 08/29/96	
Depth:	Concentrations	5		0			5 .	2. 4. 40		0	a service		5	
Units:	µg/g	Hg/g	Barda Albarta (Cra	μg/g			µg/g		121131242	µg/g			<u> нр/д</u>	Statt State
Aluminum	18000	4770		5350					ļ					
Antimony	18000	4370		5350		-	3510			6370			4730	
Arsenio	10.0	0.57		7.07			1.09		No.	1.09	232224	<	1.09	
Barium	54	8.07		54.8	CEN VERS		13.5		£	91 10 2	and a start of the		9.67	
Bervilium	0.81	< .5		< 5		<	5		e	19,3 S		-	10	
Cadmium	1.28	< .7		10.8		<	.7		V BANKS	0015000		è	 7	
Calcium	810	121		295		1	624		KLARGAN	783	1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	1	057	
Chromium	33	9,19		11.8			5.91			11.7		13	6 75	
Cobalt	4.7	1.94		< 1.42		<	1.42			3.23		<	1.42	
Copper	13.5	6,09		26.9			3,87			6.83			5.48	
Iron	18000	5980		5810	10110-101-101-10		3970			8040			5960	
Lead	48	2.43		425	S. C.		4.14	J		32.7			2.97	J
Magnesium	5500	1560		957			1040			1650			1170	-
Manganese	380	60.2		52.2			48,4			548			59.6	
Nickel	14.6	8.26		9.19			5.64			11.1			6.38	
Potassium	2400	378		250		1	642			683			649	
Selenium		< .25		< ,25		<	.25		<	.25		<	.25	
Silver	0.086	< .589	eng: xwe 2.579	< .589	1 107 A 108 P 11 4	<	.589	197 . 4	<	.589		Ř	4.46	
Sodium	131	306	el and	425		820	489	60	11116	435			555	
Yanadium	32.3	6,72		6.26			5.46			9,16			7.1	
LINC DESTICIDES/DCDS	43.9	12.0		159	201010124	[12.1		L	28.5			18.3	
A d'ada	1	< 00765		< 00765		2	00765		~	00275				
4 4'-ddi		< 00703		< .00703		\geq	00703		2	.00703		5	.00765	
Aldria		< 00729		< 00707		è.	00779		2	00707			.00707	
Chlordane - Alpha		<	т	< 005	т	è	005	т	2	00729	Ψ		.00729	Ŧ
Dieldrin		< .00629	-	< .00629	•	<	.00629	•	<	00629	•	2	00629	
Endosulfan I		< .00602		< .00602		<	.00602		<	.00602		<	00602	
Heptachlor Epoxide		< .0062		< .0062		<	.0062		<	.0062		<	.0062	
Pcb 1242		< .082	т	3.4	CZ		2.6	ZC	<	.082	т	<	.082	т
Pcb 1248	-	< .082	т	<· .082	т	<	.082	т	<	.082	Т	<	.082	Ť
Pcb 1260		< .0804		8	С		6.1	С	<	.0804		<	.0804	
SVOCs														
1,2,4-trichlorobenzene		< .04		< .4			.5		<	.04		<	.04	
1,2-dichlorobenzene		< .11		< 1		1	8		<	.11		<	.11	
1,4-dichlorobenzene		< .098		< 1		[2		<	.098		<	.098	
2-methylnaphthalene		< .049		< .5			9		<	.049		<	.049	
Accaphthese		< .036		< .4			.5		<	.036		<	.036	
Chrysene		< .12		< I		<	.6		<	.12		<	.12	
Dibenzoniran		< .U35		< .4		Ś	.Z		<	.035		<	.035	
Fluorene		< .008 C 073				IS .	د.		2	.068		5	.068	
Nachthaleve		023		~ .>			<i>د.</i>			460.		S	.033	
Phenanthrene		< .037		~ .4			1 2			1007		1	.037	
Pyrene		< .033		< .3			.8		<	033		$\left \right\rangle$.033	

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Site ID: Field Sample Number:		57E-95-20X		57B-96-07X		57B-96-07X	10 gen - 194	57B-96-08X		57B-96-08X	
Lab Samule Number:	Devens	DV45*120		DV489570		DV/Ctrai	an de la	BX570800		BX570805	
Sample Date:	Reckground	00/21/95		09/39/06	Carl Carl Street	08/38/06		DV45*522		DV4S*523	
Denth	Concentrations	e contraction of the second se	and the second	varajo n	14 (01) (der	00(10)90	engleder Site	08/29/90	the second states of the	08/19/96	2000
Units:	με/g	μ <u>ε/</u> ε		H6/5		ue/e		. Hala 0		5	0.57
Bis(2-cthylhexyl) Phthalate		< .62	<	6	<	3	<	.62	27-2012220222 2010-20	67	- A. B.
Di-n-butyl Phthalate		< .061	<	.6	<	.3	<	.061	<	061	
TPH BY GC											······
TPH MOTOR OIL PATTERN		NA		21500	1	8930	<	50	<	50	
VOCs											
*1,2-dichloroethylenes (cis And Trans)		< .003	<	.003	<	0.0085	<	0.0017	<	0.0017	-
2-hexanone		< .032	<	.032	<	0.16	<	0.032	<	0.032	
Acetone		< .017	<	.017	<	0.085	<	0.017	<	0.017	
Chloroform		< .00087	<	.00087	<	0.0044	<	0.00087	<	0.00087	
Dichloromethane		< .012	<	.012	<	0.012	<	0.012	<	0.012	
Ethylbenzene		< .0017	<	.0017	<	1.2	<	0.0017	<	0.0017	
Tetrachloroethene		< .00081		.0057	<	0.0041	<	0.00081	<	0.00081	
Toluene		< .00078	<	.00078		0.31		0.0061	<	0.00078	
Trichloroethylene		< .0028	<	.0028	<	0.014	<	0.0028	<	0.0078	
Trichlorofluoromethane		< .0059	<	.0059		0.036	<	0.0059	<	0.0059	
Xylenes		< .0015	<	.0015		22	<	0.0015	<	0.0015	
OTHER											
Total Organic Carbon									The second se		-
Total Petroleum Hydrocarbons		62.5		41400		31600		50	<	27.8	

NOTES:

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<= Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)

I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated

Exceeds established Devens background levels

							AREA 3							
Site ID: Site State		57B-96-09	X	57B-96-0	ex .		57B-96-10X			57B-96-10X			57B-96-11X	
Field Sample Number:	a de la company de	BX570900)	BX57090)5		BX571005			BX571010			BD571110	
Lab Sample Number:	Devens	DV4S*52	 A second sec second second sec	DV4S*52	25	6 300	DV4S*526	()		DV4S*527			DV4S*539	2111 S
Sample Date:	Background	08/29/96	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	08/29/9	5		09/03/96		1.00	09/03/96		8	09/03/96	2 AND STORE
Depth:	Concentrations	0		- 5	- 11 - 14 - 14 - 14 - 14 - 14 - 14 - 14	Se 275	5	1. J. 1. 1.	- 1 A	10			10 .	
Units:	hg/g	μg/g	and the second se	µg/g	A CONTRACTOR OF		µg/g	<u> </u>	Sec. 22	, µg/g	in a star		µ́g∕g	
METALS									1					
Aluminum	18000	7100		5610			3700			3560			3370	D
Antimony	0.5	< 1.09		< 1.09		<	1.09		<	1.09		<	1.09	D
Arsenic	19	5.23		8.39			36			5.15			5.17	D
Banom	34			13.3			11.2			14.4			13.2	D
Beryllium	0.81	< .5		< .5			.674			.5		<	.5	Ð
Cadmum	1.28	< .7		< ,7		<	.7		<	_7	den and a second second	<	.7	D
Calcium	810	< 100		292	•		164			1100			1380	D
Chromium	33	10.6		7.57			5.1			6.54		<	4.05	D
Cobait	4./	2.37		2.7			2.52			1.42		<	1,42	D
Copper	13.5	5.29		5,47			3.4		1	5.13			4,97	D
Iron	18000	7430		6410	-		6460			5430			5010	D
Lead	48	7.84	L	3.95	L		2,1	1		3.01	1		1.91	L D
Magnesium	5500	1540		1340		1	1020		i i	1140			989	D
Manganese	380	88,0		65.2			81.3			54.6			56.1	D
Reference in the second s	14.0	10.5		1.3			6.25			6			6.49	D
Polassium C-lastum	2400	209		521			535			717			582	D
Scientum	0.000	< .23		.23 (1994)2	STAR & STARTING	Ľ.	.25		<	.25		<	.25	Ð
Suver	0.040	C	SMSIF1	1.14		1	-269 		< rcm2*	.589	1745%	 	.589	D Alexand -
Manadium	121	G 41		7.00		622	410 5 5C		1 (g) - 507	538	<u>21</u>		535	D
Zinn	32,3	9.41		1.79			3,30			0.71			5.55	D
PESTICIDES/PCBS	45.5	10.7		11,0		1	14.4		1	12.9		_	14.9	
4 A'-dde		0081	C	< 00765		12	00765			00765		12	0076	·• · ·
4.4'-ddt		0121	C C	< 00703		2	00703		2	00703			20700	
Aldrin		< 00729	Ũ	< 00729		2	00729		2	00707			.00707	
Chiordane - Aloha		< .005	т	< .005	т	<	005	т	2	005	т	2	.00729	Ŧ
Dieldrin		< .00629	•	< .00629	•	2	00679	•	2	00570	•	2	00570	1
Endosulfan I		< .00602		< .00602		k	.00602		2	006023		2	.00029	
Heptachlor Epoxide		< .0062		< .0062		<	.0062		2	0062		2	0067	
Pcb 1242		< .082	Τ.	< .082	т	<	.082	т	<	082	т	2	087	т
Pcb 1248		< .082	Т	< .082	Ť	<	.082	ř	<	.082	Ť	<	082	Ť
Pcb 1260		< .0804		< .0804	-	<	.0804	-	<	.0804	-	<	0804	•
SVOCs						_								
1,2,4-trichlorobenzene		< .04		< .04		<	.04		<	.04		1<	.04	D
1,2-dichlorobenzene		< .11		< .11		<	.11		<	-11		<	.11	Ď
1,4-dichlorobenzene		< .098		< .098		<	.098		<	.098		<	.098	D
2-methyinaphthalene		< .049	1	< .049		<	.049		<	.049		<	.049	Ď
Acenaphthene		< .036		< .036		<	.036		<	.036		<	.036	Ď
Chrysene		< .12		< .12		<	.12		<	.12		<	.12	D
Dibenzofuran		< .035		< .035		<	.035		<	.035		<	.035	D
Fluoranthene		.14		< .068		<	.068		<	.068		<	.068	Ď
Fluorene		< .033		< .033		<	.033		<	.033		<	.033	D
Naphthalene		.048		< .037		<	.037		<	.037		<	.037	D
Phenanthrene		.11		< .033		<	.033		<	.033		<	.033	D
Pyrene		.15		< .033		<	.033		<	.033		<	.033	D

Site ID: and see also	PART AND	57B-96-09X	NAME OF STREET	57B-96-09X		57	B-96-10X			57B-96-10X			57B-96-11X	
Field Sample Number:	Second Second Sec	BX570900	6 - A - A - A - A - A - A - A - A - A -	BX570905	• * * * * *	B	X571005	100	S-453	BX571010	1.1		BD571110	and the second second
Lab Sample Number:	Devens	DV45*524		DV4S*525		D	V4S*526	÷	10.00	DV4S*527			DV4S*539	
Sample Date:	Background	08/29/96		08/29/96		%	09/03/96		- 1	09/03/96		12.00	09/03/96	
Depth:	Concentrations	0		5 5		1.1	. 5	100 million		10	- 10 M	1	10	
Units:	με/g	µg/g		HE/8	Sec. 1		µg/g			ug/g		1000	. up/p	
Bis(2-ethylhexyl) Phthalate		< .62	<	.62	<		.62		<	.62		<	.62	D
Di-n-butyl Phthalate		< .061	<	.061	<		.061		<	.061		<	.061	D
TPH BY GC														
TPH MOTOR OIL PATTERN		< 50	<	50	<		52.1		<	63		<	63	
VOCs														
*1,2-dichloroethylenes (cis And Trans)		< 0.0017	<	0.0017	<		.003		<	.003		<	.003	D
2-hexanone		< 0.032	<	0.032	<		.032		<	.032		<	.032	D
Acetone		< 0.017	<	0.017	<		.017		<	.017		<	.017	D
Chloroform		< 0,00087	<	0.00087	<		.00087		<	.00087		<	.00087	D
Dichloromethane		< 0,012	<	0.012	<		.012		<	.012		<	.012	Ď
Ethylbenzene		< 0.0017	<	0.0017	<		.0017		<	.0017		<	.0017	D D
Tetrachloroethene		< 0.00081	<	0.00081	<		.00081		<	.00081		<	.00081	D
Toluene		< 0.003	<	0.0012	<		.00078	ŀ	<	.00078		<	.00078	D
Trichloroethylene		< 0.0028	<	0.0028	<		.0028	1	<	.0028		<	.0028	D
Trichlorofluoromethane		< 0.0059	<	0.0059	<		.0059		<	.0059		<	.0059	D
Xylenes		< 0.0015	<	0.0068	<		.0015		<	.0015		<	.0015	Ď
OTHER														
Total Organic Carbon												1		
Total Petroleum Hydrocarbons		39.4	<	27.8	<		27.6		<	27.8			35.4	D
		N	OTES:											

FLC = USAEC Flagging Code

DQ = Data Qualifier

<= Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)

I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyte analyzed for and detected by non-GC/MS method

J = Value is estimated

Exceeds established Devens background levels

				AR	EA 3		
Site D:		57B-96-11X	57B-96-11X	57E-95-24X	\$7E-95-25X	57E-96-28X	57E-96-29X
Field Sample Number:	1000	BX571105	BX571110	EX572404	EX572500	EX572810	EX572911
Lab Sample Number;	Devens	DV4S*528	DV4S*529	DV45*124	DV4S*125	DY45*516	DV4S*517
 Sample Date: 	Background	09/03/96	09/03/96	09/22/95	09/22/95	08/19/96	08/20/96
· Depth:	Concentrations	5	10	4	0	10	11
Units:	µg/g	µg/g	µg/g	μg/g	µg/g	μg/g	μg/g
METALS		0770					
Aluminum	18000	2790	3940	7550 IM	7450 IM	2420	2460
Antimony	0.5	< 1.09	< 1.09	2.89	< 1.09	< 1.09	< 1.09
Arsenic	19	10	4.8	9.79	21	6.26	6.41
Banum	54	14.8	15.5	46.6	20.6	14.2	9.68
Beryllium	18.0	< .3	< .5	< .5	< ,5	< .5	< .5
Calmium	1.28	< .7	< .7	5.14	.7	< .7	< .7
Calcium	810	608	602	590	889	930	591
Cironium	33	< 4.05	6.04	19.6	22.9	< 4.05	< 4.05
Copair	4.7	< 1,42	1.97	< 1.42	7.53	< 1.42	< 1.42
Copper	13.3	4.92	4.20	28.3	15.6	4.34	3.87
Iron Land	18000	4910	4790	6010	16400	2700	3920
Lead	48	13 1	2.05 J	181	19.1	4.33 J	1.91 J
Magnesium	5500	//4	1190	12/0	4020	641	736
Manganese	380	40.8	57.8	43.4	336	31.7	43.5
NICKCI Retention	14.0	4	6.99	8.82	30.7	4.98	4.85
Polassium	2400	450	/42	310	944	407	431
Selenuum	0.026	< .25	< .25	< .25	< .25	< .25	< .25
Sadium	0.080	< .289	< .389	< .389	< .589	< .589	< .589
Vanadium	131	40.3	244	355	301	408	500
Zine	32.3	4.4	6.34	11.3	14.7	< 3.39	< 3.39
PESTICIDES/PCBS	45.91	E172	10	Notice and the second s	38.1	15.5	19,4
4 d'-dde	. 1	0.017	00765	C 00765	00765	00366	
4.4'-ddt		< 00707	< 00707	< 00703	00703	00703	< .00765
Aldrin		< 00779	< 00729	0755 C	< 00739	.00707	< 10100.
Chlordane - Alnha		< 005 T	< 005 T	< 005 T	< 005 T	.00729	< .00729
Dieldrin		< .00629	< .00629	< .00629	< 00629	< 00629	<
Endosulfan I		< .00602	< .00602	< 00602	< 00602	< 00602	< .00029 C 00502
Heptachler Epoxide		< _0062	< _0062	< 0062	< 0062	< 0062	< .0002 < .0067
Pcb 1242		< .082 T	< .082 T	< .082 T	< .082 T	< 082 T	< 082 T
Pcb 1248		< .082 T	< .082 T	3.6 CZ	< .082 T	< 087 T	< 082 T
Pcb 1260		7.4	< .0804	10 C	< .0804	1.7 C	0998 C
SVOCs							
1,2,4-trichlorobenzene		< .2	< .04	< 3	< .08	.5	< .04
1,2-dichlorobenzene		< .6	< .11	< 9	< .2	6	< .11
1,4-dichlorobenzene		< .5	< .098	< 8	< .2	4	< .098
2-methylnaphthalene		< .2	< .049	< 4	< .1	.4	< .049
Accomphtheme		< .2	< .036	< 3	< .07	< .2	< .036
Chrysene		< .6	< .12	< 10	< .2	1	< .12
Dibenzofuran] [< .2	< .035	< 3	< .07	< .2	< .035
Fluoranthene		< .3	< .068	< 5	.3	1	< .068
Fluorene		< .2	< .033	< 3	< .07	.3	< .033
Naphthalene		< .2	< .037	< 3	1.	2	< .037
Phenanthrene		< .2	< .033	< 3	.1	.4	< .033
Рутеле		< .2	< .033	< 3	.2	3	055

.

Site ID:	ASSA STATEMENT	57B-96-11X	57B-96-11X	57E-95-24X	57E-95-25X	57E-96-28X	57E-96-29X
Field Sample Number:	Logical Sector	BX571105	BX571110	EX572404	EX572500	EX572810	EX572911
Lab Sample Number:	Devens	DV4S*528	DV45*529	DV4S*124	DV45*125	DV4S*516	DV4S*517
Sample Date:	Background	09/03/96	09/03/96	09/22/95	09/22/95	08/19/96	08/20/96
- Depth:	Concentrations	5	10	4	0	10	11
Units:	P\$/R	HE/E	µg/g	hts/a	ue/e	µg/g	Hala
Bis(2-ethylhexyl) Phthalate		< 3	< .62	< 50	2	< 3	< .62
Di-n-butyl Phthalate		< ,3	< .061	< 5	< .i	< .3	< _061
TPH BY GC							
TPH MOTOR OIL PATTERN		< 2240	< 61	NA	NA	19700	286
VOCs							
*1,2-dichloroethylenes (cis And Trans)		< .003	< .003	< .003	< .003	< .003	< .003
2-hexanone		< .032	< .032	< .032	< .032	.03	< .032
Acetone		< .017	< .017	< .017	< .017	< .017	< .017
Chloroform		< .00087	< .00087	< .00087	< .00087	< .00087	< .00087
Dichloromethane	1	< .012	< .012	< .012	< .012	< .012	< 012
Ethylbenzene		< .0017	< .0017	< .0017	< .0017	.0042	< 0017
Tetrachloroethene		< .00081	< .00081	_0018	< .00081	.0094	< 00081
Tolucne		< .00078	.0018	< .00078	< .00078	< .00078	< 00078
Trichloroethylene		< .0028	< .0028	< .0028	< .0028	< .0028	< 0028
Trichlorofluoromethane		< .0059	< .0059	.0075	.0073	< .0059	<
Xylenes		< .0015	< .0015	< .0015	< .0015	.066	< 0015
OTHER							
Total Organic Carbon							
Total Petroleum Hydrocarbons		4250	< 27.8	64900	81.1	36100	262
		NOT	TES:		· · · · · · · · · · · · · · · · · · ·		

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DQ = Data Qualifier

< = Concentration was less than the certified reporting limit</p>

$$\label{eq:transformation} \begin{split} T = Non-target compound analyzed for and not detected (non-GC/MS method) \\ I = Interferences in the sample caused the quantitation and/or identification to be suspect \\ \end{split}$$

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyzed for and detected by non-GC/MS method

J = Value is estimated

Exceeds established Devens background levels

.

				AR	EA 3		A]	REA 2
Site ID: Field Sample Number: Lab Sample Number: Sample Date: Derive	Devens Background	57E-96-30X EX573006 DV4S*518 08/20/96		57E-96-3 EX57310 DV4S*5 08/21/9	1X 16 19 5	57M-95-03X BX570310 DV45*155 10/03/95	57M-95-04A BX574A01 DV45*161 10/04/95	57M-95-04X BX570402 DV4S*156 10/03/95
Depin: Liniter	Concentration	design of the		6		10	[6] B. M. KARREN, M. Stranger, and A. Stranger, Phys. Rev. Lett. 7, 100 (1997).	2
METALS	PRE	Contraction of the Contract	A CONTRACTOR OF THE OWNER	* 12942.42554688800. 942/5 -3	CARL CONTRACTOR	Pg g	P8/8	<u>μην</u> ς set of the set
Aluminum	18000	3240		3060		NA	NA	NA
Antimony	0.5	< 1.09		< 1.09		NA	NA	NA
Arsenic	19	6.74		17		NA	NA	NA
Barium	54	12		10.1		NA	NA	NA
Beryllium	0.81	< .5		< .5		NA	NA	NA
Cadmium	1.28	< .7		< .7		NA	NA	NA
Calcium	810	789		385		NA	NA	NA
Chromium	33	5.25		< 4.05		NA	NA	NA
Cobalt	4.7	< 1.42		< ì.42		NA	NA	NA
Copper	13.5	4.93		5.37		NA	NA	NA
Iron	18000	3980		5020		NA	NA	NA
Lead	48	5.07	J	25.5		NA	NA	NA
Magnesium	5500	898		745		NA	NA	NA
Manganese	380	\$3.2		51.3		NA	NA	NA
Nickel	14.6	6.05		3.94		NA	NA	NA
Polassium	2400	523		294		NA	NA	NA
Scienium		< .25		< .25		NA	NA	NA
Silver	0.086	< .389	10000	< .289	And the second of the second	NA	NA	NA
Voordium	101	430		403	1010101011	NA	NA	NA
Zing	32.5	4.92		9.36		NA	NA	NA
PESTICIDES/PCBS	43.9	10,2		1 11.7		NA NA	NA	
4 4'-ddr		< 00765		C 00765		NA	bia	NA NA
4.4'-ddt		< 00707		< 00707		NA	NA	NA NA
Aldrin		< .00729		< .00729		NA	NA	NA
Chlordane - Alpha		< .005	т	.068	с	NA	NA	NA
Dieldrin		< .00629		< .00629	-	NA	NA	NA
Endosulfan I		< ,00602		< .00502		NA	NA	NA
Heptachlor Epoxide		< .0062		.00691	С	NA	NA	NA
Pcb 1242	1	< .082	т	< .082	Т	NA	NA	NA
Pcb 1248		< .082	т	< .082	т	NA	NA	NA
Pcb 1260		< .0804		< .0804		NA	NA	NA
SVOCs ·								
1,2,4-trichlorobenzene		< .08		< .2		NA	NA	NA
1,2-dichlorobenzene		< .2		< .6		NA	NA	NA
1.4-dichlorobenzene		< .2		< .5		NA	NA	NA
2-methylnaphthalene		۱. >		< .2		NA	NA	· NA
Acenaphthene		< .07		< .2		NA	NA	NA
Chrysene		< ,2		< .6		NA	NA	NA
Dibenzoluran		< .07		< .2		NA	NA	NA
Fluoranthene		< .]		< .3		NA	NA	NA
Fluorene	1	< .07		<u>د</u> .2		NA	NA	NA
Naphthalene		2		< .2		NA	NA	NA
Phonantorene		.0/		.2		NA NA	NA	NA
ryrene	1	× ,07		1 ,5		I NA	I NA	I NA

Site ID:		57E-96-30X		57E-96-31X	57M-95-03X	57M-95-04A	57M-95-04X
Tah Sample Number	Deven	EA3/3000		EX3/3106	BX5/0310	BX574A01	BX570402
Sample Date:	Baskanaund	08/30/06	100 C	0743-319	DY45*155	- DV4S*161	DV4S*156
Danibi	Conceptulate	002090	2848. 365	08/21/90	10/03/95	10/04/95	10/03/95
Units:	Revenue and Antiones	ue/e	60.92	о це/е	J0 ng/g	1	
Bis(2-cthylhexyl) Phthalate		<	<	3	NA	NA	NA
Di-n-butyl Phthalate		< .1	<	.3	NA	NA	NA
TPH BY GC						L	
TPH MOTOR OIL PATTERN		5320		6800	NA	NA	NA
VOCs							
*1,2-dichloroethylenes (cis And Trans)		< .003	<	.003	NA	NA	NA
2-hexanone		.071	<	.032	NA	NA	NA
Acetone		< .017	<	.017 -	NA	NA	NA
Chloroform		< .00087	<	.00087	NA	NA	NA
Dichloromethane		< .012	<	.012	NA	NA	NA
Ethylbenzene		< .0017	<	.0017	NA	NA	NA
Tetrachloroethene		< .00081	<	.00081	NA	NA	NA
Toluene		< .00078	<	.00078	NA	NA	NA
Trichloroethylene		< .0028	<	.0028	NA	NA	NA
Trichlorofluoromethane		< .0059	<	.0059	NA	NA	NA
Xylenes		.13	<	.0015	NA	NA	NA
OTHER					······································	· · · · · · · · · · · · · · · · · · ·	
Total Organic Carbon					566	5450	36400
Total Petroleum Hydrocarbons		6960		18300			

NOTES:

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M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyzed for and detected by non-GC/MS method

J = Value is estimated

Exceeds established Devens background levels

		AREA 2							
Site ID:		57M-95-05X	57M-95-06X	57M-95-07X	57M-95-08A	57M-95-08B			
Field Sample Number: Manage		BX570514	BX570615	BX570704	BX578A07	BX578B04			
Lao Sample Nomoer:	Berlins	DV45-137	100405	DV45*159	DV45*162	DV4S*160			
Sample Date:	Concentration	10/03/93	10/04/93	10/04/95	10/10/95	10/06/95			
Units:	ue/r	14	19	119/9	ugla	tingle			
METALS	Co.c		and the operation of the statement of the	and all and all and all the all of the all o	HWE AND A REAL OF A REAL AND A REAL	μφς.			
Aluminum	18000	NA	NA	NA	NA	NA			
Antimony	0.5	NA	NA	NA	NA	NA			
Arsenic	19	NA	NA	NA	NA	NA			
Barium	54	NA	NA	NA	NA	NA			
Beryllium	0.81	NA	NA	NA	NA	NA			
Cadmium	1,28	NA	NA	NA	NA	NA			
Calcium	810	NA	NA	NA	NA	NA			
Chromium	33	NA	NA	NA	NA	NA			
Cobalt	4.7	NA	NA	NA	NA	NA			
Copper	13.5	NA	NA	NA	NA	NA			
Iron	18000	NA	NA	NA	NA	NA			
Lead	48	NA	NA	NA	NA	NA			
Magnesium	5500	NA	NA	NA	NA	NA			
Manganese	380	NA	NA	NA	NA	NA			
Nickel	14.6	NA	NA	NA	NA	NA			
Potassium	2400	NA	NA	NA	NA	NA			
Selenium		NA	NA	NA	NA	NA			
Silver	0.086	NA	NA	NA	NA	NA			
Sodium	131	NA	NA	NA	NA	NA			
Vanadium	32.3	NA	NA	NA	NA	NA			
Zinc	43.9	NA	NA	NA	NA	NA			
PESTICIDES/PCBS									
4,4'-dde		NA	NA	NA	NA	NA			
4,4'-ddt		NA	NA	NA	NA	NA			
Aldrin		NA	NA	NA	NA	NA			
Chlordane - Alpha		NA	NA	NA	NA	NA			
Dieldrin	1	NA	NA	NA	NA	NA			
Endosulfan I		NA	NA	NA	NA	NA			
Heptachlor Epoxide		NA	NA	NA	NA	NA			
Pcb 1242		NA	NA	NA	NA	NA			
Pcb 1248		NA	NA	NA	NA	NA			
Pcb 1260	l	NA	NA	NA	<u>NA</u>	NA			
SVOCs		214	274	N10	1	1			
1,2,4-trichlorobenzene		NA	NA	NA.	NA	NA			
1,2-dichioropenzene]	NA	NA	NA	NA	NA			
1,4-dichioropenzene		NA	NA	NA	NA	NA			
2-meinyinapiitnaiene		NA	NA NA	NA	NA	NA			
Atenaphinene		NA	NA	NA	NA	NA			
Chrysene		NA	NA	NA		NA			
Dipenzoluran		NA	NA	NA	NA	NA NA			
Riveren		NA	NA NA	NA NA	NA NA	NA			
Nashthalana		1975 NIA	INA NA	NA. NA	NA NA	NA			
Discontinuenc		NA NA	NA NA	NA NA	NA NA	NA NA			
Purene		NA NA	NA	1975 NA	NA NA	NA NA			
		100	100			IVA IVA			

Site ID:		57M-95-05X	57M-95-06X	57M-95-07X	57M-95-08A	57M-95-08B
Field Sample Number:	A STATE OF A	BX570514	BX570615	BX570704	BX578A07	BX578B04
Lab Sample Number:	Devens	DV4S*157	DV4S*158	DV45*159	DV45*162	DV45*160
Sample Date:	Background	10/03/95	10/04/95	10/04/95	10/10/95	10/06/95
Depth:	Concentrations	14	15	4	7	4
Units:	PR/E	he/e	με/ε	PE/E	µg/g	ue/e
Bis(2-cthylhexyl) Phthalate		NA	NA	NA	NA	NA
Di-n-butyl Phthalate		NA	NA	NA	NA	NA
ТРН ВҮ GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs			· · ·			
*1.2-dichloroethylenes (cis And Trans)		NA	NA	NA	NA	NA
2-hexanone		NA	NA	NA	NA	NA
Acetone		NA	NA	NA	NA	NA
Chloroform		NA	NA	NA	NA	NA
Dichloromethane		NA	NA	NA	NA	NA
Ethylbenzene		NA	NA	NA	NA	NA
Tetrachloroethene		NA	NA	NA	NA	NA
Toluene		NA	NA	NA	NA	NA
Trichloroethylene		NA	NA	NA	NA	NA
Trichlorofluoromethane		NA	NA	NA .	NA	NA
Xylenes		NA	NA	NA	NA	NA
OTHER		•				· · · · · · · · · · · · · · · · · · ·
Total Organic Carbon		673	561	1380	523	752
Total Petroleum Hydrocarbons						

NOTES:

FLC = USAEC Flagging Code

DQ = Data Qualifier

<= Concentration was less than the certified reporting limit

T = Non-target compound analyzed for and not detected (non-GC/MS method)

I = Interferences in the sample caused the quantitation and/or identification to be suspect

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyze analyzed for and detected by non-GC/MS method

J = Value is estimated

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		ÁREA 3								
Site ID:		57M-96-09X	57M-96-10X	57M-96-11X	57M-96-12X	57M-96-13X				
Field Sample Number:	2000	BX570914	BX571005	BX571105	BX571204	BX571305				
Lab Sample Number:	Devens	DV4S*530	DV4S*531	DV4S*532	DV45*563	DV4S*564				
Sample Date:	Background	08/27/96	08/30/96	08/30/96	08/29/96	08/29/96				
Depth:	Concentrations	14	- 5	5	4	5				
Units:	µg/g	µg/g	µg/g	µg/g	Hg/g	µg/g				
METALS										
Aluminum	18000	NA	NA	NA	NA	NA				
Antimony	0.5	NA	NA	NA	NA	NA				
Arsenic	19	NA	NA	NA	NA	NA				
Barium	54	NA	NA	NA	NA	NA				
Beryllium	0.81	NA	NA	NA	NA	NA				
Cadmium	1,28	NA	NA	NA	NA	NA				
Calcium	810	NA	NA	NA	NA	NA				
Chromium	33	NA	NA	NA	NA	NA				
Cobalt	4.7	NA	NA	NA	NA	NA				
Copper	13.5	NA	NA	NA	· NA	NA				
Iron	18000	NA	NA	NA	NA	NA				
Lead	48	NA	NA	NA	NA	NA				
Magnesium	5500	NA	NA	NA	NA	NA				
Manganese	380	NA	NA	NA	NA	NA				
Nickel	14.6	NA	NA	NA	NA	NA				
Potassium	2400	NA	NA	NA	NA	NA				
Selenium		NA	NA	NA	NA.	NA				
Silver	0.086	NA	NA	NA	NA	NA				
Sodium	131	NA	NA	NA	NA	NA				
Vanadium	32.3	NA	NA	NA	NA	NA				
Zinc	43.9	NA	NA	NA	NA	NA				
PESTICIDES/PCBS										
4,4'-dde		NA	NA	NA	NA	NA				
4,4'-ddt		NA	NA	NA	NA	NA				
Aldrin		NA	NA	NA	NA	NA				
Chlordane - Alpha		NA	NA	NA	NA	NA				
Dieldrin	i	NA	NA	NA	NA	NA				
Endosulfan I		NA	NA	NA	NA	NA				
Heptachlor Epoxide		NA	NA	NA	NA	NA				
Pcb 1242		NA	NA	NA	NA	NA				
Pcb 1248		NA	NA	NA	NA	NA				
Pcb 1260		NA	NA	NA	NA	NA				
SVOCs										
1,2,4-trichlorobenzene		NA	NA	NA	NA	NA				
1,2-dichlorobenzene		NA	NA	NA	NA	NA.				
1,4-dichlorobenzene		NA	NA	NA	NA	NA				
2-methylnaphthalene		NA	NA	NA	NA	NA				
Acenaphthene		NA	NA	NA	NA	NA				
Chrysene		NA	NA	NA	NA	NA				
Dibenzoturan		NA	NA	NA	NA	NA				
Fluoranthene		NA	NA	NA	NA	NA				
Fluorenc		NA	NA	NA	NA	NA				
Naphthalene		NA	NA	NA	NA	NA				
Phenanthrene		NA	NA	NA	NA	NA				
Pyrene		NA	NA	NA	NA	NA				

Site ID:	S Suppose 25	57M-96-09X	57M-96-10X	57M-96-11X	57M-96-12X	57M-96-13X
Field Sample Number:	AND	BX570914	BX571005	BX571105	BX571204	BX571305
Lab Sample Number:	Devens	DV4S*530	DV4S*531	DV4S*532	DV4S*563	DV4S*564
Sample Date:	Background	08/27/96	08/30/96	- 08/30/96	08/29/96	08/29/96
Depth:	Concentrations	14	5		4	5
Units:	PR/R	μ <u>μ</u> μ <u>μ</u> μ	H\$/\$	µg/g	HR/R	alar alar
Bis(2-cthylhexyl) Phthalate		NA	NA	NA	NA	NA
Di-n-butyl Phthalate		NA	NA	NA	NA	NA
TPH BY GC						
TPH MOTOR OIL PATTERN		NA	NA	NA	NA	NA
VOCs						
*1,2-dichloroethylenes (cis And Trans)		NA	NA	NA	NA	NA
2-hexanone		NA	NA	NA	NA	NA
Acetone		NA	NA	NA	NA	NA
Chloroform		NA	NA	NA	NA	NA
Dichloromethane ·		NA	NA	NA	NA	NA
Ethylbenzene		NA	NA	NA	NA	NA
Tetrachloroetheae		NA	NA	NA	NA	NA
Toluene		NA	NA	NA	NA	NA
Trichloroethylene		NA	NA	NA	NA	NA
Trichlorofluoromethane		NA	NA	NA	NA	NA
Xylenes		NA	NA	NA	NA	NA
OTHER						
Total Organic Carbon		792	1180	722	834	719
Total Petroleum Hydrocarbons						

NOTES:

FLC = USAEC Flagging Code

DQ = Data Qualifier <= Concentration was less than the certified reporting limit

$$\label{eq:transformation} \begin{split} T \approx Non-target compound analyzed for and not detected (non-GC/MS method) \\ I \approx Interferences in the sample caused the quantitation and/or identification to be suspect \end{split}$$

M = High duplicate spike not within control limits

C = Analysis was confirmed by a different column or technique

Z = Non-target analyzed for and detected by non-GC/MS method

J = Value is estimated

Exceeds established Devens background levels

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TA 1998 SOIL FIELD AND OFF AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			-	1			Area 2			
				575-98-01X	575-98-02X-1	57S-98-03X	575-98-04X	57S-98-05X	575-98-06X	57S-98-07X
011000000000	2001.000	the second second second second second second	lais-di	SX570101-	SX570200	SX570302	SX5704D1	SX570503-	SX570601	SD570700
. Рани.	Methods	Analyte	Units	5/19/98	5/19/98:44	5/19/98	5/19/98	5/19/98	5/19/98	5/19/98
Volatile	Organics.									
	LM19	1.1.1-Irichloroethane	100/0	IT 0044	11 0044	IT 0044	1 1 0044			
	LM19	1.2-dichloroethylenes (cis And Trans)		LT .003	LT .003	LT 003	IT 003	17.003		
	LM19	Acetone	10/0	LT 017	LT .017	LT 017	IT 017	17 017	IT 017	
	LM19	Chlorobenzene	ua/a	LT.00086	LT.00086	17,00086	1 T 00086	IT 00086	1 T 00086	
	LM19	Ethylbenzene	uo/o	LT.0017	LT_0017	LT 0017	LT 0017	1 1 0017	0033	LT 0037 d
	LM19	Toluene	uo/o	LT.00078	1 T 00076	1 T 00078	IT 00078	LT 00078	IT 00078	LT 00079 d
	LM19	Trichloroethylene	ua/a	LT .0028	LT .0028	1 T. 0028	LT 0028	11 0028	IT 0028	LT 0028 4
	LM19	Xvienes	ua/a	LT .0015	LT .0015	LT.0015	LT 0015	17 0015	LT 0015	LT 0015 d
Semivol	alile Organ	lics	in an ch	1992 (C.D. 1992 (C.D. 200			Second Second Second			CT .0010 0
	LM18	1,2-dichlorobenzene	ua/a	LT .11	LT.6	LT 2	LT 6	17 6	IT 6	ы на селото на селото На селото на
	LM18	1,4-dichlorobenzene	ug/g	LT .098	LT .5	LT 2	LT.5	11.5	11.5	h 890 T I
	LM18	2-methylnaphthalene	µg/g	LT .049	.6	LT 1	LT.2	LT.2	1T.2	1T.049 d
	LM18	Acenaphthylene	hð/ð	LT .033	.4	LT .7	LT .2	LT.2	LT.2	LT 033 d
	LM18	bis(2-ethylhexyl) Phthalate	hð/ð	LT .62	LT 3	LT 10	LT 3	LT 3	LT 3	LT .62 d
	LM18	Benzo[k]fluoranthene	hð/g	LT .066	1	LT 1	LT .3	LT .3	LT .3	LT.066 d
	LM18	Chrysene	1/g/g	LT .12	1	LT 2	LT .6	LT .6	LT.6	LT.12 d
	LM18	Fluoranthene	1/9/9	LT .068	2	LT 1	LT .3	LT .3	LT .3	LT .068 d
	LM18	Naphthalene	<u>µg/g</u>	LT .037	.4	LT .7	LT .2	LT .2	LT .2	LT.037 d
	LM18	Phenanlhrene	P6/9	LT .033	1	LT .7	LT .2	LT .2	.3	LT.033 d
	LM18	Pyrene	µg/g	LT .033	2	LT .7	LT .2	LT .2	.4	LT .033 d
Pesticide	is/PCBs	ren a Vista des des des des des des services des const	2. Sectors				to normality at a start	and a construction	Bando del Stali	and strange of the
	_LH10	Chlordane - Alpha	hð\d	ND .00133 L	ND .00133 1	<u>ND .00133 (</u>	ND .00133 I	ND .00133 1	ND .00133 1	ND .00133 ld
	LH10	Dieldrin	_ <u></u>	LT .00629	LT .00629	043 c	LT .00629	LT .00629	LT .00629	LT.00629 d
	LH10	Chlordane - Gamma	<u>µ9/9</u>	ND .00133 I	ND .00133 t	ND .00133 t	<u>ND .00133 (</u>	ND .00133 L	ND .00133 1	ND .00133 td
	<u>LH10</u>	4,4'-DDD	19/9	LT .00826	LT .00826	<u>.044 c</u>	LT .00826	<u>.027 c</u>	LT .00826	LT.00826 d
	LH10	4,4'-DDE	. vg/g	LT .00765	<u>.0194 c</u>	LT .00765	LT .00765	LT .00765	LT .00765	LT .00765 d
		4,4-001	<u>nð</u> ,ð	LT .00707	<u>,12_c</u>	<u>.0352 c</u>	LT .00707	LT .00707	LT .00707	0625_cd
THE SEARCH	LH16	PC0 1260	1 hð\ð	LT .0804]	.548 c	<u> </u>	<u>,186 c</u>	.224 c	LT .0804	.581 dc
UINEF	0071	Talal Datalay - U. data			1000			ale ale de se se		
Materia	9071	I dial Petroleum Hydrocarbons	1 hð d	393	1200	14600	1150	1750	4620	1830 d
1401213-11	1016	Boolem	i unte	47.0		54.4	1			
	1916	Cooper	14949	2.01	113	51.1	10,0	22.7	10.7	60.3 d
	1916	Мапоаресе	<u>1999</u>	3.01	41.3	14./		0.13	2.45	28.3 0
	1516	1 ead	100		274	167			128	66.3 0
	1516	Zioc	1999	14 9	150	107	20.1	44.9	24.9 IT 9 02	29/ 0
Metals	PMS			NAME OF A DESCRIPTION OF A		1.	2.0.1	23.3	LI 0.03	77.4 D
	J301	Arsenic		15 3	45	20	7 02	25	20.6	39.9 4
	J301	Selenium	ualo	1.3		2 14	0.39	0 704	0.951	2 66
VPH Ran	des (ud/o)		5.2.5	CARL STORY DE TRANSPORTE	inter station and state		Crucic Market Street	COLUMN STREET, COLUMN	1 COLO	2.00
I		n-C5 to n-C8 Allphatic	µg/g	<1.3	< 2.5 il	< 1.6 il	<1.3	<1.0	<2.3 i	< 87 i
		n-C9 to n-C12 Aliphatic	µa/a	4.3	2.5	1.91	< 1.3	2.1	3.91	151
		n-C9 to n-C10 Aromatic	uq/g	<1.3	< 2.5 [< 1.6 i	< 1.3	< 1.0	\$231	211
EPH Ran	ges (ugla)		riviedentie:	નનુષ્ણસંસ્થાનના ક		e de la companya de l		31000 1000	-forger Salta / Billion - Balan (ar	
1		n-C9 to n-C18 Aliphatic	µg/g	<44 il	<55 i	110 1	<37 il	<33 i	120 il	<170 il
		n-C19 to n-C36 Aliphatic	µg/g	68	360	3300	260	610	830	1800
		n-C11 to n-C22 Aromatic	p/g/g	<44	240	990	140	140	190	590
On Site 1	PH, µg/g+	lry)	polg .	00000000000	1001	·····	680		2500	5740

Notes:

C = analysis confirmed

d = duplicate

j = estimate

LT = less than

t = non-target compound

Received a stablished Devens background concentration

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TAI 13 1998 SOIL FIELD AND OFF AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

					Are	ea 2			Area 3	
55 525				575-98-07X -	57S-98-07X	57.S-98-08X	57 5- 98-09X-,	575-98-13X	575-98-14X	57S-98-15X
1000		Service and Service and Re-		SX570700	SX5 70701	SX570800	SX57.0900	SX571301	SX571401	SX571503
Parin :	Method	Anafyte	Units	5/19/98	5/19/98.	5/19/98	5/19/98	5/20/98	5/20/98	5/20/98
Volatile	Organics:		57 (B. 4			a de la constanción d		in the first deficition		
	LM19	1.1.1-trichloroethane	uq/a	LT 0044	IT 0044	1 T 0044	1 1 0044	17 0044	17 0044	013
	LM19	*1.2-dichloroethylenes (cis And Trans)		LT .003	.016	LT .003	11,003	11.003	17 003	LT 003
	LM19	Acetone	ug/g	.33	.073	LT .017	IT 017	IT 017	IT 017	1 7 017
	LM19	Chlorobenzene	uq/a	LT.00086	LT.00086	LT.00086	LT 00086		LT 00086	
	LM19	Ethylbenzene		LT .0017	.022	LT_0017	LT 0017	IT 0017	1 T 0017	LT 0017
	LM19	Toluene		LT.00078	LT_00078	IT 00076	LT 00078	LT 00078	LT 00078	0013
	LM19	Trichloroethylene	ua/a	LT 0028	LT.0028	LT 0028	1 T .0028	0042	11 0028	UT 0028
	LM19	Xylenes	ua/a	LT .0015	LT .0015	LT .0015	IT.0015	LT 0015	LT 0015	0041
Semiyola	aille Olgan	lcs	Service.	antz nis tranzen C	NAME OF A DESCRIPTION OF A					in the second second
	LM18	1,2-dichlorobenzene	p/g/g	LT.6	LT 1	LT.6	LT.6	.35	IT 11	IT 11
	LM18	1,4-dichlorobenzene	uq/q	LT .5	LT 1	LT.S	LT.5	.48	8P0 T I	800 T I
	LM18	2-methylnaphthalene	u a/a	LT.2	LT .5	LT.2	LT.2	17.049	1T 049	1 T 049
	LM18	Acenaphihylene	ua/a	LT .2	LT.3	LT.2	LT 2	IT 033	IT 033	LT 033
	LM18	bis(2-ethylhexyl) Phthalate	Lug/g	LT 3	LT 6	LT 3	113	IT 62	17.62	14
	LM18	Benzolk)fluoranthene	uq/q	LT .3	LT.7	LT.3	LT.3	IT.066	11 066	17 066
	LM18	Chrysene	Lala	LT .6	LT 1	LT.6	LT.6	1 1 12	IT 12	1 T 12
	LM18	Fluoranthene	uo/a	LT.3	LT.7	2	17.3	13	17.068	
	LM18	Naphthalene	ua/a	LT.2	LT.4	LT 2	IT 2	LT 037	LT 037	1 1 037
	LM18	Phenanihrene	uq/q	LT .2	LT.3	1	.8	067	IT 033	1 T 033
	LM18	Pyrene		LT .2	LT.3	2	.9		LT 033	11 033
Pesticide	s/PCBs		de Marine		in the state of state in	an at the second se		CONTRACTOR OF STREET		
	LH10	Chlordane - Alpha	ua/a	ND .00133 I	ND .00133 t	ND .00132 1	ND 00133 1	.00282 cz	ND 00133 t	ND 00133 1
	LH10	Dieldrin	uq/q	LT .00629	1.T .00629	LT .00629	.0228 c	LT.00629	LT.00529	LT 00629
	LH10	Chlordane - Gamma	μα/α	ND .00133 I	ND .00133 1	ND .00132 1	ND .00133 I	00278 cz	ND 00133 1	ND 00133 1
	LH10	4,4'-DDD	μα/α	LT .00826	LT .00826	LT .00826	.0372 c	.0234 c	LT.00825	LT 00826
	LH10	4.4'-DDE	uq/q	LT .00765	LT .00765	.0361 c	.0524 c	1 T .00765	LT 00765	LT 00765
	LH10	4,4'-DDT	uo/o	.0713 c	LT .00707	.0351 c	.18 c	LT .00707	0248 0	IT 00707
	LH16	Pcb 1260	μα/α	.466 c	.513 c	LT .0804	255 c	1.T. 0E04	474 c	1 1 0804
Other		an a		(Alexandra and a second					Statute states	C. OCO .
	9071	Total Petroleum Hydrocarbons	μα/α	6170	17000	494	1930	951	895	IT 27.9
Metals-IC	e de la companya de l					i yekara kara kara kara kara kara kara kara	in a state in the second			A restant a faite state
	JS16	Barium	P8/8	66,8	50.9	110	69.1	17.1	14.6	13.1
	JS16	Copper	µg/g	30.3	8.78	16	30.7	2.93	3,46	2.2
	JS16	Manganese	µg/g	81.8	131	46	161	170	69.5	70.8
	JS16	Lead	µg/g	320	63.9	173	. 299	22	LT 10.5	LT 10.5
	JS16	Zinc	µg/g	84.6	96.6	78.5	73.6	15.8	27.5	13.3
Metals-IC	P-MS		1997 - 1997 -	(a de la calencia de Serie de			S	Sector Sector ((*************************************
	J301	Arsenic	µg/g	61.2	44,8	13.4	43,2	25.6	28	28.2
	J301	Selenium	ug/g	4.42	3.51	2.75	4.25	1.56	IT 0.250	0.485
VPH Ran	dee (nd/d)		140025045							NAL SEA SEASO
		n-C5 to n-C8 Aliphatic	P3/8	<9.3 j	< 3.5 j	<5.3 j	<3.6 j	<1.8j	<1.4	<1.3
	i	n-C9 to n-C12 Aliphatic	p/g4	<9.3 j	15 j	6.4 j	6,4 j	3.7 j	<1.4	<1.3
		n-C9 to n-C10 Aromatic	µ9/9	12 j	< 3.5 j	13 j	<3.6 j	<1.8	<1.4	<1.3
EPH Ran	gos (µg/g)			New Age Alexander	y tahun kata dalam kata d	(\cdot,\cdot) is the (\cdot,\cdot)				
I T		n-C9 to n-C18 Aliphatic	µ9/9	<160 j	270 j	<100 j	<83 j	<46 j	<40 j	<37 j
		n-C19 to n-C36 Aliphatic	hð\ð	2100	1600	<100	240	180	150	<37
		n-C11 to n-C22 Aromatic	<u>ug/g</u>	510	450	<100	110	60	75 j	<37
On Site T	PH: µģ/g-c	lry)	pg/g al	Mail:00085-\$800€	32000	: <u>//::::::::::::::::::::::::::::::::::</u>	1500	1600	1200	
Notes:										

C = analysis confirmed

d = duplicate

j = estimate

LT = less than

t = non-larget compound

= exceeds established Devens background concentration

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			ARI	EA 2				AREA 3	·	
	Lab Sample ID:	57M-95-01X	57M-95-02X	57M-95-06X	57M-95-07X	57R-95-02X	57R-95-03X	57R-95-04X	57R-95-05X	57R-95-06X
na provenské se	Date analyzed:	12-Oct-95	- 3-Oct-95	4-Oct-95	5-Oct-95	3-Oct-95	3-Oct-95	- 3-Oct-95	3-Oct-95	2-Oct-95
A CONTRACT OF CONTRACT OF CONTRACT	Depth (bgs):	17	17	15	3	12	12	12	- 11	11
	Dilution:	1	1	1	1	1	1	1 .	5	1
Analytes	Reporting Limit									
Vinyl Chloride	2 µg/l	NA								
1,1-DCE	5 µg/l	5.0 UJ	5.0 U	5.0 UJ	5.0 U	5.0 U	5.0 U	5.0 U	25 U	5.0 U
t-1,2-DCE	2 µg/l	NA								
c-1,2-DCE	2 µg/l	NA								
Chloroform	2 μg/l	2.0 U	10 U	2.0 U						
1,1,1-TCA	2 μg/l	2.0 U	10 U	2.0 U						
Carbon Tetrachloride	2 μg/l	2.0 U	10 U	2.0 U						
Trichloroethene	2 μg/l	2.0 U	10 U	2.0 U						
Tetrachloroethene	2 μg/l	2.0 U	2.0 U	2.0 U	2.5	2.1	2.0 U	2.5	10 U	2.0 U
1,3-DCB	2 μg/l	NA	· NA	NA						
1,4-DCB	2 μg/l	NA								
1,2-DCB	2 μg/l	NA								
Benzene	2 μg/l	2.0 U	3.5	2.0 U	110	2.0 U				
Toluene	2 μg/l	2.0 U	2.6	240	2.0 UJ					
Chlorobenzene	2 μg/l	2.0 U	15	2.0 U						
Ethylbenzene	2 μg/l	2.0 U	3.1	410	2.0 U					
m/p-Xylene	4 μg/l	4.0 U	6.7	7	1100	4.0 U				
o-Xylene	2 μg/l	2.0 U	23	2.6	550	7.4				
Naphthalene	2 μg/l	NA								
TPH-dro	100 mg/l	NA								
TPH-gro	100 μg/l	100 U	43000 E	100 U						

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting limit

NA = Not analyzed

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						AREA 3		•••••	· · · · · · · · · · · · · · · · · · ·	
- Martin Salah Salah	Lab Sample ID:	57R-96-08X	57R-96-09X	57R-96-09X	57R-96-10X	57R-96-11X	57R-96-11X	57R-96-12X	57R-96-12X	57R-96-13X
served she to added	Date analyzed:	20-Aug-96	21-Aug-96	27-Aug-96	21-Aug-96	21-Aug-96	28-Aug-96	21-Aug-96	28-Aug-96	21-Aug-96
	Depth (bgs):	11	13	13A	13	15	15A	14	14A	11
	Dilution:	1	1	1	1	1	1	1 -	1	1
Analytes	Reporting Limit									
Vinyl Chloride	2 μg/l	2.0 U	2.0 U							
1,1-DCE	5 μg/l	2.0 U	2.0 U							
t-1,2-DCE	2 μg/l	2.0 U	2.0 U							
c-1,2-DCE	2 μg/l	2.0 U	2.0 U							
Chloroform	2 μg/l	2.0 U	2.0 U							
1,1,1-TCA	2 μg/l	2.0 U	2.0 U							
Carbon Tetrachloride	2 μg/l	2.0 U	2.0 U							
Trichloroethene	2 μg/l	2.0 U	2.0 U							
Tetrachloroethene	2 μg/l	2.0 U	2.7	2.0 U						
1,3-DCB	2 μg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
1,4-DCB	2 μg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
1,2-DCB	2 μg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
Benzene	2 μg/I	2.0 U	2.0 U							
Toluene	2 μg/l	2.0 U	2.8							
Chlorobenzene	2 μg/l	2.0 U	2.0 U							
Ethylbenzene	2 µg/l	2.0 U	2.0 U							
m/p-Xylene	4 μg/l	4.0 U	4.0 U							
o-Xylene	2 μg/l	2.0 U	2.0 U							
Naphthalene	2 μg/l	NA	NA	2.0 U	NA	NA	2.0 U	NA	2.0 U	NA
TPH-dro	100 mg/l	NA	NA							
TPH-gro	100 μg/l	NA	NA							

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reportin;

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

						AREA 3				
	Lab Sample ID:	57R-96-14X	57R-96-14X	57R-96-15X	57R-96-15X	57R-96-16X	57R-96-16X	57R-96-17X	57R-96-18X	57R-96-19X
ときることものでの	Date analyzed:	21-Aug-96	28-Aug-96	23-Aug-96	26-Aug-96	23-Aug-96	28-Aug-96	26-Aug-96	26-Aug-96	28-Aug-96
	Depth (bgs):	10	11A	10	10A	10	11	11	- 11	11
	Dilution:	1	1	100	1	1	1	1	1	50
Analytes	Reporting Limit									
Vinyl Chloride	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
1,1-DCE	5 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
t-1,2-DCE	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
c-1,2-DCE	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
Chloroform	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
1,1,1-TCA	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
Carbon Tetrachloride	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
Trichloroethene	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
Tetrachloroethene	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	2.7	2.0 U	2.0 U	100 U
1,3-DCB	2 μg/l	NA	2.0 U	NA	2.0 U	NA	2.0 U	2.0 U	2.0 U	100 U
1,4-DCB	2 μg/l	NA	2.0 U	NA	2.0 U	NA	2.0 U	2.0 U	2.0 U	100 U
1,2-DCB	2 μg/l	NA	2.0 U	NA	2.6	NA	3.9	2.0 U	2.0 U	110
Benzene	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
Toluene	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	2.0 U	10	2.0 U	2.0 U	170
Chlorobenzene	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	100 U				
Ethylbenzene	2 μg/l	2.0 U	2.0 U	200 U	2.0 U	190				
m/p-Xylene	4 μg/l	4.0 U	4.0 U	450	4.0 U	720				
o-Xylene	2 μg/l	2.0 U	2.0 U	490	2.4	2	2.0 U	2.0 U	2.0 U	450
Naphthalene	2 µg/l	NA	2.0 U	NA	16	NA	3.6	2.0 U	2.4	130
TPH-dro	100 mg/l	NA								
TPH-gro	100 μg/l	NA								

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reportin:

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

					ARJ	EA 3				
STORES BUILDING STORES	Lab Sample ID:	57R-96-20X	57M-95-03X	57B-96-08X	57B-96-09X	57M-96-09X	57M-96-10X	57M-96-11X	57M-96-12X	57M-96-13X
	Date analyzed:	28-Aug-96	4-Oct-95	29-Aug-96	29-Aug-96	27-Aug-96	3-Sep-96	3-Sep-96	3-Sep-96	3-Sep-96
A state of the second se	Depth (bgs):	14		10	10	17	10	10	10	5
	Dilution:	. 1	1	1	1	.1	1	1	1	1
Analytes	Reporting Limit									
Vinyl Chloride	2 μg/l	2.0 U	NA	2.0 U						
1,1-DCE	5 μg/l	2.0 U	5.0 UJ	2.0 U	95	2.0 U				
t-1,2-DCE	2 μg/l	2.0 U	NA	2.0 U						
c-1,2-DCE	2 μg/l	2.0 U	NA	2.0 U						
Chloroform	2 μg/l	2.0 U								
1,1,1-TCA	2 μg/l	2.0 U								
Carbon Tetrachloride	2 μg/l	2.0 U								
Trichloroethene	2 μg/l	2.0 U								
Tetrachloroethene	2 μg/l	2.0 U	2.0 U	3.2	2.0 U	2.0 U	2.0 U	2.7	2.0 U	2.0 U
1,3-DCB	2 μg/l	2.0 U	NA	2.0 U						
1,4-DCB	2 μg/l	2.0 U	NA	3.1	2.0 U					
1,2-DCB	2 µg/l	2.0 U	NA	5.8	2.0 U	2.0 U	2.0 U	2.5	2.0 U	2.0 U
Benzene	2 μg/l	2.0 U								
Toluene	2 μg/l	2.0 U	14	2.0 U	2.9					
Chlorobenzene	2 μg/l	2.0 U								
Ethylbenzene	2 μg/l	2.0 U	9.1	6.4	2.0 U	2.0 U	2.0 U	2.6	2.0 U	2.8
m/p-Xylene	4 μg/l	4.0 U	31	17	4.0 U	4.0 U	4.0 U	4	4.0 U	4.0 U
o-Xylene	2 μg/l	2.0 U	17	9.2	2.0 U	2.0 U	2.0 U	4.7	2.0 U	2.0 U
Naphthalene	2 μg/l	2.0 U	NA	7.1 J	2.0 U					
TPH-dro	100 mg/l	NA								
TPH-gro	100 μg/l	NA	100 U	NA						

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

NA = Not analyzed

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			AREA 3 7M-96-13X 57M-96-08A 57M-96-08B 57B-95-02X 57B-95-03X 57B-95-04X 57B-95-05X 57B-95-06X											
	Lab Sample ID:	57M-96-13X	57M-96-08A	57M-96-08B	57B-95-02X	57B-95-03X	57B-95-04X	57B-95-05X	57B-95-06X					
of the provide states and	Date analyzed:	3-Sep-96	11-Oct-95	9-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95	3-Oct-95					
	Depth (bgs):	5D	- 4	4	17	21	13	15	- 14					
	Dilution:	1	1	1	1	1	1	1	1					
Analytes	Reporting Limit													
Vinyl Chloride	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
1,1-DCE	5 μg/l	2.0 U	5.0 UJ	5.0 U										
t-1,2-DCE	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
c-1,2-DCE	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
Chloroform	2 μg/l	2.0 U	2.0 UJ	2.0 U										
1,1,1-TCA	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Carbon Tetrachloride	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Trichloroethene	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Tetrachloroethene	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
1,3-DCB	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
1,4-DCB	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
1,2-DCB	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
Benzene	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Toluene	2 μg/l	2.6	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Chlorobenzene	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Ethylbenzene	2 μg/l	2.6	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
m/p-Xylene	4 μg/l	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U	4.0 U					
o-Xylene	2 μg/l	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U					
Naphthalene	2 μg/l	2.0 U	NA	NA	NA	NA	NA	NA	NA					
TPH-dro	100 mg/l	NA	NA	NA	NA	NA	NA	NA	NA					
TPH-gro	100 μg/l	NA	100 U	100 U	100 U	100 U	100 U	100 U	100 U					

Notes:

U = Concentration is less than reporting limit

J = Value is estimated

E = Concentration exceeds the maximum reporting

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NA = Not analyzed

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Site ID Sample Date: Field Sample Number		57M-95-01A MD5701X2		57M-95-01X MOG/01X7		57M-95-01X	57M-95-01X	57M-95-01X		7M-95-01X
Lab Sample Number:	Devents	DV4F*455		DV4W-455		DV4F*167	DV4W2167	DVAE+168		4A5/0122
Sample Date:	Hackground	2/113/96		02/13/96		10/30/95	10/10/95	1771796		108
Depth:	Coacentrations	24		24			24			7.4 7.4
Units	µg/1	με/L		μg/L		ug/L	10 AL	11. June / 1		
METALS			1			······································			1	
Aluminum	6870	< 141 DF	<	141	D	< 141 F	4180	< 141 F	<	141
Arsenie	10.5	< 2.54 DF	<	2.54	D	< 2.54 F	24.5	< 2.54 F	<	2.54
Barium	39.6	51.9 DF		12.8	D	14.8 F	33.9	12.2 F	-	12.6
Cadmium	4.01	< 4.01 DF	<	4.01	D	< 4.01 F	< 4.01	< 401 F	<	4 01
Calcium	14700	5850 DF		5960	D	5620 F	6650	5860 F	1	6050
Copper	8.09	< 8,09 DF	<	8.09	Ð	< 8.09 F	10.1	< 809 F	1	8.00
Iron	9100	< 38.8 DF	<	38.8	D	72.9 F	5660	< 38.8 F	2	38.8
Lead	4.25	< 1.26 DF	<	1.26	D	1.41 F	8.46	< 126 F	2	1 26
Magnesium	3480	639 DF		627	Ď	612 F	1200	651 E		650
Manganese	291	31.2 DF		30.4	D	385 F	512	105 E	1	1010
Potassium	2370	1730 DF		1410	Ď	1090 F	7700	1540 F		32.1
Sodium	10800	16500 DF	100	16600	ฒีก็	14500 E	17300	1,040 F	Prozest.	1120
Zinc	21.1	< 211 DF	<	711	n D	< 711 F	21.1	13700 T F		16200
PESTICIDES/PCBS				27.1		21.1	1 21.1	× 21.1 F		
Endosulfan Ii			<	.023	D		< n23	Y		011
SEMIVOLATILE ORGANICS			1							.025
1,2-dichlorobenzene			<	1.7	D		< 17 N		[Z	17
1.4-dichlorobenzene			<	1.7	- D		< 17 N			1.7
2-methyinaphthalene			4	17	n		C 17 N			1.7
4-methylobenni			12	57	ñ		5 I.7 N			1.7
Diethyl Phthalate			2	2	ň		S 32 N			.52
Nachthalene			12	5	5					4
Bis(2-ethylberyl) Phthalate			2	48	Ď		A 48 N			., , ,
VOLATILE ORGANICS			<u> </u>				15 4.6 IX		L	4.8
*1.2-dichloroethylenes (cis And Trans)			<	5	n		12 5	1	~	e
1.1.1-trichloroethane			2	.5	ñ				C	.5
Acctone			<	13	Ď					
Carbon Tetrachloride			l c	58	ň		59		D .	15
Chioraform			2	5	D			•	C .	.38
Dichloromethane			2	23	ň		2.2		C .	
Ftbybenzene			12	5	Ď		2.3		0	2.3
Starene			12	5	ñ				1.	
Tetrachloroathana					D				<	.>
Toluene				5	5		1.8		< <	1.6
Trichlorosthylene			D.		d n		.03	1	Ι.	1.2
Yulener			12		D		.36		<	.5
AYICIGS			1	.64	<u> </u>		.84	L	<	.84
Alkaliaity			1	6000	D		2000			
Chloride				27400	5		8000		l	5000
Nitrite Nitrate per Cresifie				2/400	D		28500		1	25200
Nitrogen By Kieldshi Mathod				200	D D		210		ł	1200
Phoenhote				200	D D		210		i	248
r nospilate Sulfata			[`	13.3	D D		280		í.	13.6
Sunate			-	11000	ů U		< 10000		l i	10000
Total Dissolved Solids				91000	D		76000		I.	70000
1 Olai Hardness				18400	Ð		14000	1	l i	20000
Total Suspended Solids			1<	4000	D		232000	1		5000
Tatal Paralaum Hutanahana				101			1			
rotal retroicum rivorocarbons			15	181	ע		355	1	<	183

1995 Stores Site ID: Sample Dates		57M-95-02X			57M-95-01X		1	7M-95-02X+;		t-:-:-:4	7M-595-02-X25-527-53		57A4-05-04 A	
Field Sample Namber:		MX5701X1			MX5702X1			1X5702X2			dX5702X2		MIXS704A1	
Lab Sample Namber:	Devens	DY4E*169			DV4W4169			0V4F*170		l i i i	VJW-176		TI V45*171	
Sample Date:	Rargeround	10/10/498			10/30/95			07/37/04			n1)(1)nC		1.001	
Denth	Cancentrations				10			10			10			
	i i i i i i i i i i i i i i i i i i i													
METALS	**********************	1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-	*************	1		******	1004040404				in the contraction of the contra			
Aluminum	010	141	F	+	141			141						
	00/0		r		141			141	-	<	141	<	141	F
Arsenic	10.5	\$ 2.54	r	<pre></pre>	2.54		<	2.54	F	<	2,54		2.77	F
Banum	39.0	24.8	F		21			10.4	F		10.3	1990 B	45.6	F
Cadmium	4.01	4.01	F	<	4.01		<	4.01	F	<	4.01	<	4.01	F
Calcium	14700	19300	F	870	13600			13100	F		12900		7770	F
Copper	8.09	< 8.09	F	E40	9.81		<	8.09	F	<	8.09	<	8,09	F
Iron	9100	< 38.8	F	1	132		<	38.8	F	<	38.8		1380	F
Lead	4.25	< 1.26	F		3.25		<	1.26	F	<	1.26	<	1.26	F
Magnesium	3480	1520	F		1050			765	F		747	1	774	F
Manganese	291	< 2.75	F	1	7.52		<	2.75	F	<	2.75		1410	F
Potassium	2370	2180	F	l	1800			1560	F		1110		1240	F
Sodium	10800	44300	F		35300			13700	F		13200	1	6400	F
Zinc	21.1	< 21.1	F	<	21.1		<	21.1	F	<	21.1	<	21.1	F
PESTICIDES/PCBS									•					
Endosulfan Ii				<	.023					<	.023			
SEMIVOLATILE ORGANICS														
1,2-dichlorobenzene				<	1.7	N				<	1.7			
1,4-dichlorobenzene				<	1.7	N				<	1.7			
2-methylnaphthalene				<	1.7	N				<	1.7			
4-methylphenol				<	.52	N				<	.52			
Diethyl Phthalate					2.3	N					3.2			
Naphthalene				<	.5	N				<	5			
Bis(2-ethylhexyl) Phthalate				<	4.8	N				<	4.8			
VOLATILE ORGANICS				<u> </u>										
*1,2-dichloroethylenes (cis And Trans)				<	.5					<	.5	1		
1,1,1-trichloroethane				<	.5					<	.5			
Acctone				<	13					<	13			
Carbon Tetrachloride				<	58					<	58			
Chloroform				<	.5					<	5			
Dichloromethane				<	2.3					< l	23			l
Ethylbenzene				l c	5					2	5			
Styrene				è	5					2	.5			
Tetrachloroothene				2	16					2				
Toluena				12	5					`	1.0			
Trichloroethulene				0							1.0			
Vulence										2	.5			
WET CHEMICTRY				<u> </u>	-04					<	.84	.l		
AND DE CHEMISIKE					00000									
Akaumy					20000						140000			
					55000						17600			1
Nume, Millate-non Specific					2300						060			1
Nitrogen By Kjeldani Method				<	183						238			
rnosphale				<	13.5						15.8	[
Sunate					15000						14000	1		
Total Dissolved Solids					153000						96000	1		
LI OLAI Mardness					42000						37200	1		
Total Suspended Solids					4000					<	4000			
OTHER									·					
Total Petroleum Hydrocarbons	1			<	169					<	187	1		

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Site:ID Sample Date:		57M-95-04A	57M1-95-D4A	57M-95-04A	57M-95-04B	5761-95-64B	57/1595-0410
Teb Sample Number	Detrorte	DVAU441	DEXTINGAL	0125570442	01243704131	MX5704H1	MX5704B2
Cample Date	Rackmenium	11/01/05	07/14/06	0111106	LINAR 180	UY4W 185	
Denth	Concentrations			4.4	11111132	1.11/11/25	0,2/14/90
Units	ur/L	цел	u#/f	(10)/[THE T		
METALS						<u>, , , , , , , , , , , , , , , , , , , </u>	
Aluminum	6870	395	< 141 F	< 141	< [4] F	< 141	< 141 F
Arsenic	10.5	13.4	3.94 F	4.9	< 2.54 F	< 254	< 354 E
Barium	39.6	63.5	27.7 F	27.6	10.7 F	981	10.6 5
Cadmium	4.01	< 4.01	< 4.01 F	< 4.01	< 401 F	< 401	< 401 F
Calcium	14700	8880	7680 F	7720	9660 F	9770	12600 E
Copper	8.09	10.3	< 8.09 F	< 8.09	< 8.09 F	< 809	< 800 F
Iron	9100	6310	3530 F	3610	< 388 F	87 4	< 39.9 F
Lead	4.25	2.17	< 1.26 F	< 1.26	< 1.26 F	184	< 176 F
Magnesium	3480	828	904 F	866	981 F	000	1370 6
Manganese	291	3700	533 F	552	356 F	387	516
Potassium	2370	4140	1360 F	1030	2640 F	7790	2990 F
Sodium	10800	11800	5820 F	5850	30700 F	28900	34500 F
Zinc	21.1	25.3	< 21.1 F	< 21.1	< 21.1 F	< 21.1	< 711 F
PESTICIDES/PCBS					• · · · · · · · · · · · · · · · · · · ·		
Endosulfan Ii		< .023		< .023	1	< .023	
SEMIVOLATILE ORGANICS							
1,2-dichlorobenzene		< 1.7		< 1.7		< 1.7	
1,4-dichlorobenzene		< 1.7		< 1.7		< I.7	
2-methylnaphthalene		< 1.7	1	< 1.7		< 1.7	
4-methylphenol		< .52		< .52		< .52	
Dicthyl Phthalate		< 2		< 2		< 2	
Naphthalene		د. >		< .5	[< .5	
Bis(2-ethylhexyl) Phthalate		< 4.8		< 4.8		5	
VOLATILE ORGANICS							
1,2-dichloroethylenes (cis And 1 rans)		3.6		1.8		< .5	
1,1,1-tricoloroetnane				< .5		< .5	
Accione				< 13	l	< 13	
Caroon 1 cirachionde		.38		< .58		< .58	· .
Distignment		< .3		< .3		< .5	
Dichloromethane		2.3		< 2.3		< 2.3	
Eurypenzene				< .5		< .5	
Stylene		× .5		< .5 17		< .5	
Telueet				16]	< 1.6	
Trichlesesthulese		< .3 ,		0.		< .5	
Yulener		. 84		1.9		< .5	
WET CHEMISTRY		\$,64	I	.84	I	< .84	
Alkalinity		32000	1	14000	1	18000	
Chloride		8340		6040		14000	
Nitrite Nitrate-non Specific		323		148		1800	
Nitrogen By Kieldahl Method		514		333	[193	
Phosphate		26.6	l	13.8		< 13.1	
Sulfate		16000		16000		35000	
Total Dissolved Solids		69000	1	72000		112000	
Total Hardness		12000		18400		< 1000	
Total Suspended Solids		15000		6000		2000	
OTHER				, 0000		20000	
Total Petroleum Hydrocarbons		< 181	1	< 187	[< 170	

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Field Sample Number:		1701-95-44B MX57D4B2	5/M-95-05X MEX\$705X1	57M-95-05X MX5705X4	57M-954ISX MX5705X2	57M-95-05X NIX5705X2	57M-95-06X MX5706X1
Lau Sample rumber. Sample Date:	Backerninni	DV411-459 112/14/96	DY48*1/5 11/07/95	DV4W1175 1C/07/95	DV4R*176	D⊽4₩*176	DV4F*177
Depthi	Concentrations	29.5	15	15	15	4.//carbo 15	16 0
Uner	µg/1,	μg/L	µg∕L	μg/L	μrg/L	ag/L	ng/L
METALS				-			
Aluminum	6870	< 141	< 141 F	< 141	< 141 F	< [4]	< 141 F
Arsenic	10.5	< 2.54	< 2.54 F	< 2.54	< 2.54 F	< 2.54	< 2.54 F
Barium	39.6	10.4	16.4 F	16	13.9 F	13	21.6 F
Cadmum	4.01	< 4.01	< 4.01 F	< 4.01	< 4.01 F	< 4.01	< 4.01 F
Calcium	14700	12700	5320 F	5290	5320 F	\$010	8760 F
Copper	8.09	< 8.09	< 8.09 F	< 8.09	< 8.09 F	< 8.09	< 8.09 F
Iron	9100	< 38.8	47.4 F	< 38.8	< 38.8 F	< 38.8	< 38.8 F
Lead	4.25	< 1.26	< 1.26 F	< 1.26	< 1.26 F	< 1.26	< 1.26 F
Magnesium	3480	1390	< 500 F	522	507 F	< 500	668 F
Manganese	291	530	9.3 F	10	5.95 F	5.79	319 F
Potassium	2370	2800	1330 F	1560	<u>1660</u> F	1560	2170 F
Sodium	10800	34900	11300 F	10700	<u>10100</u> F	9000	7680 F
Zinc	21.1	< 21.1	< 21.1 F	< 21.1	< 21.1 F	< 21.1	< 21.1 F
PESTICIDES/PCBS				· · · · · · · · · · · · · · · · · · ·			
Endosulian in		< .023		< .023		< .023	
SEMIVOLATILE ORGANICS			- <u> </u>				
1,2-dichorobenzene				< 1.7		< 1.7	
1,4-dichioropenzene		< 1.7		< 1.7		< 1.7	
2-methylnaphillaiene		< 1.7		< 1.7	1	< 1.7	
4-incinyiphenoi		< .52		< .52		< .52	
Nachthatara		2		< 2		2.7	
Dis(2 attachered) Distribute		< .5 400		< .5		< .5	
VOLATILE OPCANICE		400	1	7.7	I I	< 4.8	
*1.2-dishlorosthylenes (eis And Tenns)		/ 5	r		r		
1,2-archioroethyneides (Cis And Traits)		·				< .5	
Acatona Sectora		~ 13				< .5	
Carbon Tetrachlorida						< 13	
Chlomform		5		.38		< .58	
Dichloromethane		< 33				< ,5	
Ethulbenzene		< <u>4.3</u>		2.3		< 2.3	
Stimene		<		< .3		< .5	
Tetrablamethese		<		< .5		< .5	
Tolume		· 1.0		< 1.0		< 1.6	
Telebloreethulane				< .3		1.2	
Yulanaa		< ,5 < 94		< .3		< .5	
WET CHEMISTRY		<u> </u>	[84	I	< .84	
Alkalinity		\$330	Y	17000	· · · · · · · · · · · · · · · · · · ·		
Chloride		53000		12000		224000	
Nitrite Nitrate-non Specific	1	1700		050		13200	
Nitrogen By Kieldahl Method	1	< 183		- 183		8/U	
Phosphate		- 105	1	177		< 183 < 1122	
Sulfate		21000		11000		< 10000	
Total Dissolved Solids		174000		42000		 10000 62000 	
Total Hardness		41700	1	42000		62000	
Total Suspended Solids		< 4000	[14800	· ·	1/000	
OTHER			L	1403/0	Ii	<u> </u>	
Total Petroleum Hydrocarbons		< 191	1	< 176	r	< 170	

Site:ID Sample Date:		57M-95-4)6X	57	M-95-06X			57/11-95-06/		37M-95-07X			7M-95-07X		57M-95-07X	
Lab. Controls Many		Division and the second	*		LCX1001.2			MX3-00A2		MX5707X1			MX5707X1		MX5707X2	
Canna Jiam	Backmentar	11/0/11	2		1.10 111 mc			DY41118		UVAK 179			DV4W*179		DV4F*130	
Counterpart Andres	DECKETDURU	11104/7	S		a 11 31 30			.u2/15/%i		10/31/95			10/31/95		02/14/96	
These	concentrations	5.0			10.5			1019					8		8	
METALS	1111111111111111111111		-1-1-1-1-1-1-1-1-1-1-1	<u> </u>		<u> </u>	141111		<u></u>	Second (Decore)				<u></u>	11111111111111111111111111111111111111	
Aluminum	6870	2480			167	F		204	-	141	r.			_		
Arsenic	10.5	693		<	2 54	F	-	204		141	r	15	141	<	141	F
Barium	39.6	141			177	F		19.6		2.54	r	1	2.54	<	2.54	F
Cadmium	4.01	< 4.01			4.01	r r		401		25.1	r T	Ι.	23		9.06	F
Calcium	14700	9540			4660	r r	`	4.01		4.01	r 7	<pre></pre>	4.01	<	4.01	F
Conper	2008	< 8.00		1	8 00	r		9/20		4420	r		4410		2590	F
Iron	0110	2790		2	38.8	c	12	299		0.07	r	12	8.09	<	8,09	F
Lead	4 25	217		è	1 26	F	12	30.0	1 2372	0.0	r Br	1	38.8	<	38.8	F
Magnesium	3480	1380		è	500	F	12	500	فلافقا بر	600	7 (E) 7		9.05	<	1.26	F
Manganese	201	100000	OR SET		173	F		170	1`	200	r	1°	500	<	500	F
Potassium	2370	2700	0.420		1350	- 	1	1320		10.4	r		19.2		20.9	F
Sodium	10800	7670	and the second		2760	r		1320	1000	1020	3 5	ENCHOR OF	917		775	F
Zinc	211	100000000000000000000000000000000000000	an a	e	2100	r r	-	2800	1	211	3 r		22700		10400	F F
PESTICIDES/PCBS		10.0.00000 00.000000 00.000	Sage Neerood			<u>.</u>		1.14	_	21.1	r	<u> </u>	21.1	<	21.1	F
Endosulfan Ii		0271	С				<	073	- <u>-</u>							
SEMIVOLATILE ORGANICS								,027				· _	.025			
1,2-dichlorobenzene		< 1.7		• T			<	17	1				17	- NI		
1.4-dichlorobenzene		< 17					è.	17					1.7	N		
2-methylnaphthalene		< 17					2	17					1.7	N		
4-methylohenol		< 57						50	E				1.7	N		
Diethyl Phthalate		c 2						.32				1	.52	N		
Naphthalene		2						4 e					2	N		
Bis(2-ethylbexyl) Phthalate		< 48					2	.9				5	.5	N		
VOLATILE ORGANICS							L	4.0				<u>ا ج</u>	4,8	<u>N</u>		
*1.2-dichloroethylenes (cis And Trans)		< 5		1		i	<	5	1			1	£			
1.1.1-trichloroethane		< 5					-	5								
Accione		< 13					è.	13					.5			
Carbon Tetrachloride		< .58					Z	58					13			
Chloroform		< .5					<	5					٥L. ک			
Dichloromethane		< 2.3					2	23								
Ethylbenzene		< 5					è	5					2.5			
Styrene		< 5					è	.5 K								-
Tetrachloroethene		< 16					2	16				`	.5			
Tolucne		< 5					2	5.0					4			
Trichloroethylene		< 5					2						د.			
Xylenes		< 84					2						.5			
WET CHEMISTRY		• .01						.04				<u> </u>	.84			
Alkalinity		10000		1			2	5000		- 149			7000	-		
Chloride		7570					2	2120					7000			
Nitrite, Nitrate-non Specific		1600					~	2120					28500	l		
Nitrogen By Kieldahl Method		< 183					/	193	1				570			
Phosphate		< 123					2	10.2				<	183			
Sulfate		10000		1			2	10000				<	13.3			
Total Discolved Solide		12000		1			~	10000				<	10000			
Total Hardpare		42000		1				22000					74000			
Total Suspended Colids		2000						15200					16000	1		
OTHER		19000		-l			<u> </u>	4000					5000			
Total Petroleum Hydrogarbons		< 177		γ			~	177								
		- 174		1			~	177	1			- S	107			

Site ID Sample Date:		57M-95-07X	57NI-95-08A	57M1-95-08A	57M-95-08A	5701-95-08A	5741-95-088
creat photoe and one		MIAD/U/AL	OIXXIUSAL	MLADUBAI	MX5708A2	MX5708A2	N1X5708B1
Lan Santhe Funder.	Devens	D341-4/06	LYY48 18	DV4W 181	DV4F*182	DV4W*182	DV4F*183
Dalispin Dalic.	Dackgruudu	UG114190	11491173	104093	42/10/90	U2/15/96	11/01/95
				A		×	23
METALS	<u></u>						
Aluminum	6870	141	< 141 F	< 141	IC 141 E		
Arsenic	10.5	< 254	< 754 F	< 2.54			41 F
Barium	10.6	0 10	168 5	12.7	2.34 F	2.54	< 2.54 F
Cadmium	401	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	10,0 F	13,7	10.8 F	15.2	9.35 F
Calcium	14700	7660	8220 12	7040	4.01 F	4.01	< 4.01 F
Corner	8.00	2000	8320 F	7040	7480 F	6940	14100 F
Irap	0.07	20.0	- 100 F	8.09	< 8.09 F	< 8.09	< 8.09 F
Lead	9100	10.0	S 38.8 F	140	413 F	712	< 38.8 F
Managerium	4,20	1.20	< 1.20 F	< 1.26	< 1.26 F	< 1.26	< 1.26 F
Magnesium	3480	1 200	843 F	779	842 F	765	1500 F
manganese	291	41.4	2420 F	1740	819 F	724	30 F
Polassium	2370	809	1450 F	1350	1380 F	704	2360 F
Sodium	10800	10500	4440 F	3880	4310 F	4010	28900 F
Linc	21.1	< 21.1	< 21.1 F	< 21.1	< 21.1 F	< 21.1	<u>< 21.1 F</u>
Federal Servers				1			
SEMINOLATH E ODCANICS		.023		< .023		< .023	
1.2 dishlombanzana		17		1.1		····	
1,2-dichlorobenzene				< 1.7		< 1.7	
1,4-Cichiorobenzene				< 1.7		< 1.7	
			ľ	< 1.7		< 1.7	
Pinted Distribute		.52		< .52		< .52	
Dietnyi Pritialate		< 2		< 2		< 2	
Naphinaiene		< .3		< .5		< ,5	
Bis(2-etnyinexyi) Phinainte		< 4.8	· · · · · · · · · · · · · · · · · · ·	< 4.8		< 4.8	
VOLATILE ORGANICS			1	<u> </u>	····		
1,2-dichloroethylenes (cis And Trans)		< .5		< .5		< .5	
1, 1, 1-ITICRIOFOCINANC		< .3		< .5		< .\$	
Acctone		< 13		19		< 13	
Carbon Tetrachloride		< .58		< .58		< .58	
Chiorotorm		< .5		< .5		< .5	
Dichloromethane		< 2.3		< 2.3		< 2.3	
Ethylbenzene		< .5		< .5		< .5	
Styrene		< .5		< .5		< .5	
Tetrachloroethene		3.9		< 1.6		< 1.6	
Toluene		.58		< .5		< .5	
Trichloroethylene		< .5		< .5		< .5	
Xylenes		<		< .84		< .84	
WET CHEMISTRY							
Alkalinity		6000		15000		14000	
Chloride		11000		4060		5160	
Nitrite, Nitrate-non Specific		1400		360		290	
Nitrogen By Kjeldahl Method		< 183		181		< 183	
Phosphale		< 13.3		19		< 13.3	
Sulfate		< 10000		11000		10000	
Total Dissolved Solids		51000		25000		70000	
Total Hardness		10800		2000		2000	
Total Suspended Solids		8000		4000		4000	
OTHER							
Total Petroleum Hydrocarbons		< 195		< 180		< 183	

Site ID. Sample Date: Field Sample Number:	6	57M-95-08B MX 5708B1	57M-95-08B BEX5708B2	57M-95-08B MIX5708B2	5774-95-03X MD5702X2		7M-95-03X MD5703X2	
Lan sample Nomber Sample Date:	Devens	11/07/95	D7/15/96	07/15/96	LU V41° 458 117/14/06		DV4W 458	
Depth	Concentrations	23		23	1211-11-20 12		12	
Units	ing/L	με/Έ	μg/L	µg/L	₩g/L		ng/L	
METALS						1		<u>. بن با ماندا ما ما ما ما ما</u>
Aluminum	6870	1770	< 141 F	< 141	< 141 DF	<u> </u>	263	D
Arsenie	10,5	< 2.54	< 2.54 F	< 2.54	36.6 DF		27.5	D
Barium	39.6	11.4	7.56 F	7.31	37,4 DF		47.6	D
Cadmium	4,01	< 4.01	< 4.01 F	< 4.01	< 4.01 DF	<	4.01	Ď
Calcium	14700	17400	12700 F	13600	10100 DF		8890	D
Copper	8,09	39.1	< 8.09 F	< 8.09	< 8.09 DF	<	8 09	D
Iron	9100	2150	< 38.8 F	< 38.8	10600 DF		7400	Ď
Lead	4.25	9.76	< 1.26 F	< 1.26	< 1.26 DF	<	1.26	D D
Magnesium	3480	1910	1340 F	1460	775 DF	1	758	Ď
Manganese	791	81.3	997 F	001	JAST DF	1	777	5
Potassium	2370	1930	1260 F	1410	1860 DF		1930	5
Sodium	10800	30000	79800 F	30700	1950 DF		1650	D D
Zinc	211	< 21.1	< 211 F	21.1	1950 DF	EXC		u م 18
PESTICIDES/PCRS				1 21.1	How	62069	No. CO. Co.	<u>a D</u>
Endosulfan li		< 023	· · · · · · · · · · · · · · · · · · ·	< 023	1	12	023	
SEMIVOLATILE ORGANICS			· · · ·		1	<u> </u>		D
1.2-dichlorobenzene		< 1.7		< 1.7	· · · · · · · · · · · · · · · · · · ·		17	
1.4-dichlorobenzene		< 1.7		< 17		12	17	ñ
2-methylpaphthalene		< 17		< 17		2	17	D
4-methylohenol		< 52		< 57			57	5
Diethyl Philalate		< 7		< 2		D .	.32	5
Nachthalene						L.	26	D
Big(7-cthulberry!) Phthalate		69		100			2.0	D
VOLATILE ORGANICS			·	300				<u> </u>
*L 2-dichloroethyleges (cis And Trans)		< 5		5		12	~	D
1 Listrichloroethane		2 5		6 5		D	د.	2
Acetone		e 13				D		5
Carbon Tetraphoride		- 15 - 59		59			15	U R
Chlosoform		ac. >					.28	D
Dishlaromathana						12		D
Ethulhaurana		~ 2.3		2.3		 `	2.3	D
Stugene		<					1.9	D
Styrene				< .3		<	د.	D
Tetrachioroethene		< 1.0		< 1.6		<	1.6	D
Toluene		< .5		.53			1.8	D
Trichloroethylene		1.5		1.8		<	.\$	D
Xylenes		< ,84		< .84			8.3	D
WETCHEMISTRY					······································	,		
Alkalinity		15000		6000			38000	D
Chlonde		53000		46000		<	2120	D
Nitrite, Nitrate-non Specific		1600		1800			270	D
Nitrogen By Kjeldahl Method		276		< 183			419	D
Phosphate		28.5		< 13.3		<	13.3	D
Sulfate		22000		21000		<	10000	D
Total Dissolved Solids		120000		160000		I	81000	D
Total Hardness		52000		51200		1	28400	D
Total Suspended Solids		19000		< 4000		L	12000	D
OTHER								
Total Petroleum Hydrocarbons		< 178		< 183		<	187	D

TABLE 7-15										
RI GROUNDWATER OFF-SITE ANALYTICAL RESULTS										
AOC 57										

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Field Sample Number:		57M-95-03X MX5703X1	57M-95-033 MX 5701X1	57M-95-03X MX5761X2	57M-95-03X	0701-95-03X	57M-96-09X
Lab Sample Number:	Devens	DV4F*171	DV4W*171	DV4F*172	DV4W*177	NV4W2517	10,437,09771
Sample Date:	Background	11/02/95	11/02/95	02/14/96	02/14/96	10/01/96	10/01/04
Depth:	Concentrations	12	12	17	12		
Unuc	µg/L	μg/L	μert	$\mu_{e}\eta_{c}$	port.	30°/L	
METALS		1					
Aluminum	6870	< 141 F	< 141	< 141 F	< 141	85	190
Arsenic	10.5	71 F	74	40.1 F	42.3	33.2	< 2.54
Barium	39,6	26.4 F	25.1	36.4 F	37.4	87.2	176
Cadmium	4.01	< 4.01 F	< 4.01	< 4.01 F	< 4.01	8.67	< 301
Calcium	14700	18600 F	18200	9820 F	9740	7940	8150
Copper	8.09	< 8.09 F	< 8.09	< 8.09 F	< 8.09	< 5	2 5
Iron	9100	17500 F	17800	11300 F	11700	12400	191
Lead	4,25	2.39 F	< 1.26	< 1.26 F	< 1.26	< 1.26	< 126
Magnesium	3480	846 F	880	712 F	715	< 1000	1110
Manganese	291	699 F	687	343 F	348	100000000000000000000000000000000000000	10.6
Potassium	2370		2500	2370 F	2130	7400	12.0
Sodium	10800	2190 F	2130	1910 F	1840	< 2290	1330
Zinc	21.1	< 21.1 F	< 21.1	43.3 F	42.8	192	- 358
PESTICIDES/PCBS				Kell & Zummer and the converse state	ENV OF BUILD THE PARTY AND AND THE	Contraction of the second seco	> 33.0
Endosulfan li	ſ		< .023	T	< .023	< 023	< 023
SEMIVOLATILE ORGANICS						.013	.023
1,2-dichlorobenzene		· · · ·	7	1	< 1.7	98	e 17
1.4-dichlorobenzene		1	5		< 17	56	- 17
2-methylnaphthalene			< 3		< 17	44	
4-methylphenol					2 52	15	
Diethvl Phthalate			< 4		2 2	1	54
Naphthalene			20		28	20	
Bis(2-ethylhexyl) Phthalate			< 10		< 48	- 18	
VOLATILE ORGANICS			1		N 1.0	4.0	< <u>4.0</u>
*1.2-dichloroethylenes (cis And Trans)			< .5	Τ	< .5	< 5	
1.1.1-trichloroethane			< .5		< 5	2 5	
Acetone			< 13	1	< 13	< 13	2 13
Carbon Tetrachloride			< .58		< 58	45	~ 58
Chloroform			< .5		< .5	10	
Dichloromethane			< 2.3		< 2.3	29	2 23
Ethylbenzene			47		1.9	46	
Styrene			< .5		< .5		
Tetrachloroethene			3.7		< 16	26	
Tolucne			49		19	10	< 1.0 - c
Trichloroethylene			< .5		2 5	50	د. > • •
Xvlenes			200 X		03	200	- C. >
WET CHEMISTRY				· · · · · · · · · · · · · · · · · · ·		200	.04
Alkalinity			56000	1	38200		
Chloride			3510		2 2120		
Nitrite, Nitrate-non Specific			1100		260	159	
Nitrogen By Kieldahl Method			733		495	334	- 193
Phosohate			240		719	324	< 163 19.6
Sulfate			< 10000		< 10000	10,2	26.0
Total Dissolved Solids			72000		78000	86000	40000
Total Hardness			14000		26800	166000000	40000
Total Suspended Solids			162000		12000	8000	10000
OTHER					11000	8070	1>000
Total Petroleum Hydrocarbons			337	1	< 107	< 167000	c 167

.

Site ID Sample Date			57/1-96-10X				\$7M-96-11X MTI5711X1			57M-96-11X MY57117Y1		5/M-96-12A		5701-96-13X		G3M-92-02A	
Lab Sample Number:	Devens		nvawisia				DV41V+305			DV4W*535		BV4W*306		DV4W*307		INVARAINS	
Santple Date:	Background		10/02/96				10/02/96			10/02/96		10/02/96		10/02/96		10/31/95	
Depthi	Concentrations		0				0			0		Q		0		76	
Umis	μg/L		μg/L				με/1.			µg/L		减几		ng/L		nig/L	
METALS															i i i i i i i i i i i i i i i i i i i	Induct A Contractor	
Aluminum	6870		183			1	200	D		161	2	2450		65.2	<	141	F
Arsenic	10.5	<	2.54			100	170	D	1000	170	1	3.73	1	8.96	<	2.54	F
Barium	39.6		36.1				11.6	D		11		41.8		12.1		12.3	F
Cadmium	4.01	<	3.01			<	3.01	D	<	3.01	<	3.01	<	3.01	<	4.01	F
Calcium	14700		2020				9730	Ð		9310		9110		16900		6780	F
Copper	8,09	<	5			<	5	D	<	S	<	5	<	5	<	8,09	F
Iron	9100		105				26500	D	6.20	25900		1540	1	1910	<	38.8	F
Lead	4.25	<	1.26			<	1.26	D	<	1.26	<	1.26	<	1.26	<	1.26	F
Magnesium	3480	<	1000				1190	D		1190		1080	<	1000		584	F
Manganese	291		206				2100	D		1990		126		346		6.68	F
Potassium	2370	<	1000				1920	D		1680	-	1730		1650		1110	F
Sodium	10800	<	2290				4050	D		3990	ł	5050		2850		20300	F
Zinc	21.1		37.2	<u> </u>		<	35.8	D	<	35.8	<	35.8	<	35.8	<	21.1	F
PESTICIDES/PCBS																	
Endosulfan Ii	<u> </u>	<	.023		К	<	.023	D	<	.023	<	.023	<	.023			
SEMIVOLATILE ORGANICS											·····	····					
1,2-dichlorobenzene		<	1.7	v	K		3.4	D		2.6	<	1.7	<	1.7			
1,4-dichlorobenzene		<	1.7	v	K.	<	1.7	a	<	1.7	<	1.7	<	1.7			
2-methylnaphthalene		<	1.7	v	к	<	1,7	D	<	1.7	<	1.7	<	1.7			
4-methylphenol		<	.52	v	ĸ	<	.52	D	<	.52	<	0.52		5			
Diethyl Phthalate		<	2	v	ĸ	<	2	D	<	2	<	0.2	<	2			
Naphthalene		<	.5	v	ĸ		3.3	D		2.5	<	0.5	<	.5			
Bis(2-ethylhexyl) Phthalate		<	4.8	<u>v</u>	<u> </u>	L	6.7	D	<u> <</u>	4.8	<	4.8	<	4.8			
VOLATILE ORGANICS						·····			·								
*1.2-dichloroethylenes (cis And Trans)		<	.5				.89	D		.74	<	.5	<	.5			
1,1,1-trichloroethane		<	.5			<	.5	D	<	.5	<	.5	<	.5			
Acetone		<	13			<	13	D	<	13	<	13	<	13			
Carbon Tetrachloride		<	.58			<	.58	D	<	.58	<	.58	<	.58			
Chloroform		<	.5			<	.5	D	<	.5	<	.5	<	.5			
Dichloromethane		<	2.3			<	2.3	D	<	2.3	<	2.3	<	2.3			
Ethylbenzene		<	۶.				4.6	D		4.2	<	.5		2.8			
Styrene		<	.5			<	.5	D	<	.5	<	.5	1	8			
Tetrachloroethene		<	1.6				4.8	D	1	4.7	<	1.6	<	1.6			
Toluene		<	.5			[.67	D	1	.86		1.1		2.9			
Trichloroethylene		<	۶,				1.1	D		1.1	<	.5	<	.5			
Xylenes		<	.84			[6.5	D		6.8	<u> <</u>	.84	<	.84			
WET CHEMISTRY													I				
Alkalinity						i i			I 1								
Chloride									I 1								
Nitrite, Nitrate-non Specific		1.	54					-	_>۱	10	1	17.1		132			
Nitrogen By Kjeldahl Method		<	183			1	390	D	1	448	<	183	<	183			
Phosphate		<	13.3			1	70.8	D	1	65.6		55,2	<	13.3			
Sulfate						1			1				1				1
Total Dissolved Solids			26000			1	93000	D	1	86000		58000		67000			
Total Hardness			10800000			1	1140000000	D	E	161000000		35200000		104000000			
Total Suspended Solids		<u> <</u>	4000			I	25000	D	L	26000	L	101000		4000			
OTHER																	
Total Petroleum Hydrocarbons		<	167			<	169	D	1<	167	<	167	<	167			

Site: D. Saniple Date:		G1M-92-01	900 900	G3M292-02	X	GJM-92-02X	GCIMI-92-07X		G3M-92-07X		G3M	92-078
Tatu pampe rumper	Deverie	NLAUAVAA1 NVAUVAL		DUMENTAL		1171723ULAL	MDIG307X1		MDG307X1		MX(507X1
Samuela Train	Background	10/31/05		07/11/0/		07/17/06	LIN48-448		UY4W*448		DY4	117165
Traile	Concentrations					442-14230	4441743		10/31/95		10/	31/95
T mits	ueff.	16/1				47						^
METALS				1	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		<pre>statestatestatestatestatestatestatesta</pre>	<u></u>	2011 1020 1020		<u></u>	gala de la composition de la compositio
Aluminum	6870	< 141		< 141	F	< 141	< 141 D		169	D		
Arsenic	10.5	< 2.54		< 2.54	F	< 2.54	< 254 DE	1	7 54	D D		141 P
Barium	39.6	12.3		34.6	F	33	154 D		2.34	D		L04 F
Cadmium	4.01	< 4.01		< 401	F	< 401	15 401 D	1	4.01	D D		2.0 F
Calcium	14700	6860		10100	F	10200	11700 D		4.01	D		
Copper	8.09	< 8.09		< 8.09	F	< 8.09	C 809 D	-	11200	U D		1900 F
Iron	9100	93.5		< 38.8	- न	< 38.8	389 D	1	0.09	D	- 8	1.09 F
Lead	4.25	< 126		c 126	Е	1 1 26	136 DF		247	D		8.8 F
Magnesium	3480	588		805	F	901	1.20 DF		1.26	D	< 1	.26 F
Manganese	201	7 54		016	5	100	032 D	i i	004	D D		52 F
Potassium	2370	1280		7400		1700	2.75 D		0.88	D	< 2	.75 F
Sodium	10800	21700	2.53	40100	F	1700	2210 D	153	2110	D	2 Normonaliza	090 F
Zinc	21.1	- 211	<u>1929</u>	43100	Side F	30800	39100 D		39100	D	38	5700 F
PESTICIDES/PCRS	21.1	~ 21.1		21.1	r	~ 21.1	<u> 21.1 D</u>	<	21.1	D	< 2	1.1 F
Endosulfan li		< 023		1		< 023	T	1	^^^		r	
SEMIVOLATILE ORGANICS		025	· · · ·					1	.023	U		
1.2-dichlorobenzene		< 17	N			< I7			1 7	D N	1	
1.4-dichlorobenzene		< 17	N			< 17			1.7	DN		
2-methylnaphthalene		< 17	N			e 17		D	1.7	D N		
4-methylohengi		< 57	N			< 107 C 52		D	1.7	D N		
Dictivel Phthalate		< 2	N			34			.52	D N	1	
Naphthalene		< 5	N			< 5			2	N N		
Bis(2-ethylhexyl) Phthalate		< 4.8	N			< 48				DN		
VOLATILE ORGANICS				r				<u> </u>	4.0	n n	I	
*1.2-dichloroethylenes (cis And Trans)		< .5				< .5	1	12	5	D	1	
1,1,1-trichloroethane		< .5				< .5		12	5	n D		
Acetone		< 13				< 13	1	2	13	n		
Carbon Tetrachloride		< .58				< .58		12	58	n n		
Chloroform		< .5				< .5		12	5	ñ		
Dichloromethane		< 2.3				< 23		2		n n		
Ethylbenzene		< .5				< 5	-	12	5	2		
Styrene		< 5				~ ~		D	.5	5		
Tetrachloroethene		< 1.6				< 16		12	.5	D D		
Toluene		< 5				~ 5			1.0	2		
Trichloroethylene		< 5				2 5			.3	u n		
Xylenes		< .84				< 84		12	 84	U D		
WET CHEMISTRY							1	1	,04	0		
Alkalinity		10000				5000	1	1	12000	n		
Chloride		3 5000				2000			66000	n n		
Nitrite, Nitrate-non Specific		1500				1300			1000	5		
Nitrogen By Kieldahl Method		< 183				< 183		1	181	5		
Phosphate		< 13.3				< 13.3		1	101	2		
Sulfate		< 10000				11000			15:5	ñ		
Total Dissolved Solids		93000				195000			10000	5		
Total Hardness		20000				30400	1		36000	5		
Total Suspended Solids		< 4000				< 4000	1	1	4060	5		
OTHER		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		1			₹		4000	U	·	
Total Petroleum Hydrocarbons		< 183				< 181	1	<	181	n		

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Sits ID: Sample Date:		G3M-92-07X	GIM-92-07X	C3M92-07A	C3M-92-07X
rield Sample C(un)ber:		MXC307X1	MXG307X2	MXG307X2	MXG307X3
Lab Sample Number:	Devens	DV4W*365	DV4F*166	DV4W*166	DY4W*536
Sample Date:	Rackground	10/31/95	02/13/96	Q2/13/96	10701796
Depth	Concentrations	27	27	27	Q
METAL C	1999-1999-1999-19 9 2/19	μ ε/ ξ.	1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 -	<u>jen i jen i</u>	1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -
METALS					
Aluminum	6870	< 141	< 141 F	< 141	41.4
Arsenic	10.5	< 2.54	< 2.54 F	< 2.54	< 2.54
Barium	39.6	15.4	16.4 F	15.9	28.3
Cadmium	4.01	< 4.01	< 4.01 F	< 4.01	< 3.01
Calcium	14700	11800	9580 F	9480	15200
Copper	8,09	< 8.09	< 8.09 F	< 8.09	5,14
Iron	9100	135	< 38.8 F	< 38.8	< 36.8
Lead	4.25	< 1.26	< 1.26 F	< 1.26	< 1.26
Magnesium	3480	668	591 F	541	< 1000
Manganese	291	2.99	< 2.75 F	< 2.75	< 2.5
Potassium	2370	2240	2430 F	1740	2440
Sodium	10800	38400	42300 F	42900	52000
Zinc	21.1	< 21.1	< 21.1 F	< 21.1	43
PESTICIDES/PCBS			·····		1 I I I I I I I_
Endosulfan li		< .023	1	< .023	< .023
SEMIVOLATILE ORGANICS					
1,2-dichlorobenzene		< 1.7 N	1	< 1.7	< 1.7
1,4-dichlorobenzene		< 1.7 N		< 1.7	< 17
2-methylnaphthalene		< 1.7 N		< 1.7	< 1.7
4-methylphenol		< .52 N		< .52	< 57
Diethyl Phthalate		2.4 N		< 2	< 2
Naphthalene		< .5 N			2 5
Bis(2-ctbylheryl) Phthalate		< 48 N		< 48	
VOLATILE ORGANICS					14
*1.2-dichlorocthylenes (cis And Trans)		< 5	1	< 5	~ ~
1 1 1-trichloroethane		< 5		2 5	
Acetone	-	< 13			
Carbon Tetrachloride		c 59			< 13 c 50
Chloroform		53			< .38
Dickloromethane					<
Ethylheartene				× 2.3	< 2.3
Surana				< .,	< .3
Styrene				< .3	< .>
Teluarioroculene		× 1.0		S 1.0	< 1.6
Toluche		· · · ·		.89	< .5
1 richloroethylene		< .>		< .3	< .5
AVICECS		<u> </u>]	< .84	< .84
WETCHEMISTRY		10000			
Aikaimity		12000		320000	
Children Street Street		00000		71000	
Nume, Narate-non Specific		1300		1900	
tvitrogen By Kjeidani Method		< 183 189		343	< 183
Phosphate		18.2		< 13.3	< 13.3
Suilaic		15000	ł	13000	
Lotal Dissolved Solids		172000		174000	216000
Total Hardness		34000		27200	48800000
Total Suspended Solids		< 4000		9000	< 4000
OTHER					
Total Petroleum Hydrocarbons		< 181		< 189	< 167000
		Notes:			

<= Concentration was less than the certified reporting limit D = Duplicate Sample

T = Non-target compound analyzed for and not detected (non-GC/MS method)<math>I = Interferences in the sample caused the quantitation and/or identification to be suspect<math>M = High duplicate spike not within control limits

.

J = Value is estimated

F = Filtered Sample

X =Analyte concentration above reporting limit

TABLE 7-16 1998 GROUNDWATER FIELD AND OFF-SITE ANALYTICAL RESULTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		Are	a 2	Area 3							
		57P-98-02X	57P-98-02X	57M-96-11X	57M-96-11X	:57M-96-11X	57M-96-11X	57P-98-03X	57P-98-03X	57P-98-04X	57P-98-04X
		MX5702XX	MX5702XX	MX5711XX	MX5711XX	MD5711XX	MD5711XX	MX5703XX	MX5703XX	MX5704XX	MX5704XX
Parameter	Units	5/26/98	5/26/98	5/27/98	5/27/98	5/27/98	5/27/98	5/26/98	5/26/98	5/26/98	5/26/98
Volatile Organics GC/MS											
*1,2-dichloroethylenes (cis And Trans)	µg/L	13		LT 0.5		LT 0.5 d		LT 0.5		LT 0.5	
Chlorobenzene	µg/L	LT 0.5		LT 0.5		LT 0.5 d		LT 0.5		0.88	
Ethylbenzene	µg/L	LT 0.5		20		20 d		3.2		LT 0.5	-
Toluene	µg/L	0.54		LT 0.5		LT 0.5 d		LT 0.5		LT 0.5	
Methylcyclohexane	µg/L										
Tetrachloroethene	µg/L	LT 1.6		5.4		5.5 d		LT 1.6		LT 1.6	
Trichloroethylene	µg/L	0.71		3.7		3.8 d		LT 0.5		LT 0.5	
Xylenes	µg/L	LT 0.84		5.9		5.8 d		5 s		LT 0.84	D
Semivolatile Organics by GC/MS											
1,2-dichlorobenzene	µg/L	LT 1.7		6.4		3.9 d		4.9		LT 1.7	
1,4-dichlorobenzene	µg/L	LT 1.7		2.7		LT 1.7 d		LT 1.7		LT 1.7	
2-methylnaphthalene	µg/L	LT 1.7		LT 1.7		LT 1.7 d		2		LT 1.7	
bis(2-ethylhexyl) Phthalate	µg/L	6.4		LT 4.8		LT 4.8 d		52		5.8	
Naphthalene	μg/L	LT 0.5		6.2		3.3 d		8 s		LT 0.5	
Metals											
Arsenic	µg/L	54.4	73f	84.4	133f	83.6 d	138 df	13.4	20.9f	7.68	12.7f
Barium	µg/L	16.4	16f	18	9.2f	41.8 d	8.8 df	10.2	7.2f	8.4	6.4f
Copper	µg/L	LT 5	LT 5f	LT 5	LT 5f	8.54 d	LT 5 df	LT 5	LT 5f	LT 5	LT 5f
Lead	μg/L	16.0	4.40f	LT 1.00	LT 1.00f	8.07	LT 1.00f	1.85	LT 1.00f	3.76	LT 1.00f
Manganese	µg/L	439 RJ	434 RJf	2640 RJ	2660 RJf	2460 d RJ	2380 d RJf	690 RJ	754 RJf	1480 RJ	1420 RJf
Total Suspended Solids	μg/L	110000		2120000		46700 d	-	312000		633000	
VPH Ranges (µg/L)											
n-C5 to n-C8 Aliphatic	µg/L	<20		91		88		<20		<20	
n-C9 to n-C12 Aliphatic	µg/L	<20		75j		<20j		<20		<20	
n-C9 to n-C10 Aromatic	µg/L	<20	107	93j		250j		310		<20	
EPH Ranges (µg/L)											
n-C9 to n-C18 Aliphatic	µg/L	<500j		<500j		<500j		<500j		<500j	
n-C19 to n-C36 Aliphatic	μg/L	<500		<500		<500		<500		<500	
n-C11 to n-C22 Aromatic	µg/L	<200		<200j		<200j		<200		<200	
On-Site TPH (mg/L)	mg/L	<50		<50		<50		<50		<50	

Notes:

Flag codes are in small case letters following result

d = duplicate sample result

f = filtered result

Data qualifiers are in capital letters following result

R = Rejected data, J = low blank spike recovery in this lot was low

j = estimated

= exceeds established Devens background concentrations

Field Sengle Yunder: Dore The Sengle Yunder: Derive Th	Site ID:		57D-95-03X		57D-95-03X		57D-9	5-03X		. 5	7D-95-04X		10.00	57D-95-04X																									
Lab Sampe Yomber: Dyrester Dyrester <thdyrester< th=""> <thdyrester< th=""> <thdyrester< th=""></thdyrester<></thdyrester<></thdyrester<>	Field Sample Number:	5.00	DD570300		DX570300		DX5	0302		1	X570401			DX570402																									
Seque (base) Backgreened (001295) (001295) (001205) (01205) (01205)	Lab Sample Number:	Devens	DV4S*431		DV4S*187		DV4	5*188		J	V4S*189			DV4S*190																									
Depti Constructions 0 0 2 <th2< th=""> <th2< th=""> 2</th2<></th2<>	Sample Date:	Background	09/13/95	Statistics and the	09/13/95	Contraction of the	09/1	3/95			09/14/95			09/14/95	18 N .																								
Units UGC UGC<	Depth:	Concentrations	0	and a second	0			2	1.		1			2	1946.06																								
METALS I </td <td>Units:</td> <td>UGG</td> <td>UGGʻ</td> <td>and the second second</td> <td>UGG</td> <td>Sector Contract Sector</td> <td>U.S. MARKEN</td> <td>G</td> <td></td> <td></td> <td>UGG</td> <td>2. Section</td> <td></td> <td>UGG</td> <td>ALC: NO DE LA</td>	Units:	UGG	UGGʻ	and the second second	UGG	Sector Contract Sector	U.S. MARKEN	G			UGG	2. Section		UGG	ALC: NO DE LA																								
Aluminum 18000 14700 D 1130 3380 7210 7910 Barian 9 122 D 607 35 5 5 17.5 10.2 Barian 128 D 6.7 25 < 5.18	METALS																																						
Areasic 19 320 D 180 17.5 17.5 10.2 Bardium 6.81 5 D 5 25 5.5 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.7 - 7.6 -	Aluminum	18000	14700	D	11300		39	80			7210			7910																									
	Arsenic	19	120	• D	180	Antonio	7	5			17.5			10.2																									
Berylinin 0.81 5 D < 5 5 2.8 Cardiam 810 (0000 D) 8670 3110 (1100) 7 2 1	Barium	54	121	D	67.1		2	5		<	5.18			14.8																									
	Beryllium	0.81	< .5	D	< .5		< .	5		<	.5			2.8																									
Cacham E10 10.0 D 8870 110 110 250 260 Chondian 33 352 D 13.5 3.9 < 4.65	Cadmium	1.28	< .7	D	< .7		< .	7		<	.7		<	.7																									
	Calcium	810	10300	D	8670		31	10 🦷			11100			2610																									
	Chromium	33	45:2-,	D	39.1		13	.8		<	4.05			71.6																									
Copper 13.5 3.26 D 13.5 5.39 200 200 14.6 Iton 18000 31500 D 2650 23 410 13.7 Magnesim 5500 200 566 23 410 13.7 Magnesim 5500 2070 D 566 23 410 13.7 Magnesim 5000 2070 D 566 26 53.3 866.4 Mecury 14.6 2400 273 D<	Cobalt	4.7	29.9	D	11.5		3.	9		<	1.42		<	1.42																									
	Copper	13.5	42.6	D	13.5		5.	39			201			14.6																									
Lad 44 220 D 560 23 410 13.7 Magnesim 5500 4130 D 5600 1170 1380 100 13.7 Marganesic 380 22070 D 695 262 55.3 6.4 Wercury 14.6 270 D 695 < 05	Iron	18000	31500	D	26700		88	80			5280			4030																									
Magnesium 5500 4130 D 3500 1170 1380 1060 Magnesce 330 2773 D $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$ 053 $<$	Lead	48	320	D	66		2	3			410			13.7																									
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Zine 43.9 447.0 D I25 46.6 Image: I25 8.03 PESTICIDES/PCBS -78 CD .34 C .058 C < .00826	Vanadium	32.3	46,4	D	21.7		< 3.	39		<	3.39		<	3.39																									
PESTICIDES/PCBS 4,4*ddd .78 CD .34 C .058 C < .00826	Zine	43.9	457	D	125	ALC: N	46	.6			129		<	8.03																									
4,4'ddd 7.8 CD 3.4 C 0.58 C < 0.0826 < 0.0826 < 0.0826 4,4'-ddt	PESTICIDES/PCBS																																						
4.4*ddc .2.6 CD .0.974 C .0.139 C < .00765 < .00765 4.4*ddt .125 CD < .00707	4,4'-ddd		.78	CD	.34	с	.0	58	С	<	.00826		<	.00826																									
44'dt	4,4'-dde		.26	CD	.0974	с	.01	39	С	<	.00765		<	.00765																									
Dieldrin < .00629 D < .00629 < .00629 < .00629 < .00629 < .00629 Peb 1260 < .0804	4,4'-ddt		.125	CD	< .00707		< .00	707		<	.00707	M	<	.00707	М																								
Peb 1260 < .0804 C .0804 < .0804 < .0804 </td <td>Dieldrin</td> <td></td> <td>< .00629</td> <td>D</td> <td>< .00629</td> <td></td> <td>< .00</td> <td>529</td> <td></td> <td><</td> <td>.00629</td> <td></td> <td><</td> <td>.00629</td> <td></td>	Dieldrin		< .00629	D	< .00629		< .00	529		<	.00629		<	.00629																									
SEMIVOLATILE ORGANICS BenzQKJfluoranthene 3 D < .7	Pcb 1260		< .0804	D	< .0804		- 08	<u>04</u>			0904		-	.0804																									
Benzo[k]fluoranthene 3 D < .7 < .3 .066 < .066 Chrysene .6 D 1 .6 .12 .12 Fluoranthene 3 D 2 .7 .53 .068 Phenanthrene 3 D 2 .7 .53 .033 Pyrene 6 D 5 1 .98 .11 Disel 75.5 D <	SEMIVOLATILE ORGANICS	3					00	V7		<	.0004		<u>ام</u>																										
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Benzofklfluorantheae							~		<	.0004		<u> </u>																										
Fluoranthene 7 D 5 2 1.2 < 0.068 Plenanthrene 3 D 2 .7 .53 < 0.033			3	D	< .7		<	3		<	.066		<u> </u>	.066																									
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Dickloromethane < .06 D < .012 .15 < .012 Tetrackloroethene .004 D <	Chrysene Fikoranthene Phenanthrene Pyrene TPH BY GC Dicsel Tphgas VOLATILE ORGANICS Acetone		< .6 7 3 6 75.5 81.5 2	D D D D D D D D D	< .7 < 1 5 2 5 < 8 < 8 < 8 < 8		<	.8		<	.066 .12 1.2 .53 .98 		<pre></pre>	.066 .12 .068 .033 .11 .11 .8 .8 .017																									
Tetrachloroethene < .004 D < .0081 .0046 < .00081 < .00081 Toluene < .004	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Dicsel Tphgas VOLATILE ORGANICS Acetone Chlorobenzene		 3 6 7 3 6 75.5 81.5 2 < .004	D D D D D D D D D D D D	 .7 1 5 2 5 < 8 8 < .017 .00086 		<	.8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8		<	.0666 .12 1.2 .53 .98 169 8 	· · · · · · · · · · · · · · · · · · ·	V V V V V V V V V V V V V V V V V V V	.066 .12 .068 .033 .11 .11 .017 .00086																									
Toluene < .004 D < .0078 .0028 .02 < .00078 Trichlorofluoromethane < .03	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Diesel Tpligas VOLATILE ORGANICS Acetone Chlorobenzene Dichloromethane		 3 .6 7 3 6 75.5 81.5 2 < .004 < .006	D D D D D D D D D D D D D D	 .7 1 5 2 5 < 8 8 < .017 .00086 .012 		< .00 < .1 < .1 .1 .00 .00 .00 .00 .00	.8 .8 .8 .6 .16 .12		<	.0604 .066 .12 1.2 .53 .98 .069 .8 .31 .00086 .15		V V V V V V V V V V V V V V V V V V V	.066 .12 .068 .033 .11 .017 .00086 .012																									
Trichlorofluoromethane < .03 D < .0059 .015 < .0059 .0059 OTHER	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Dissel Tpligas VOLATILE ORGANICS Acetone Chlorobenzene Dichloromethane Tetrachloroethene		3 6 7 3 6 75.5 81.5 004 004 004	D D D D D D D D D D D D D D D	 .7 1 5 2 5 		<pre></pre>	.8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8 .8	· · · · · · · · · · · · · · · · · · ·	<	.0604 .066 .12 1.2 .53 .98 .00086 .15 .00081		V V V V V V V V V V V V V V V V V V V	.066 .12 .068 .033 .11 .017 .00086 .012 .00081																									
OTHER 293000 D 283000 76900 602000 109000	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Diesel Tphgas VOLATILE ORGANICS Acetone Chlorobenzene Dichloromethane Tctrachloroethene Toluene		 3 6 7 3 6 75.5 81.5 2 .004 .004 .004 .004 .004 	D D D D D D D D D D D D D D D D	 .7 1 5 2 5 < 8 < .017 .00086 .012 .00081 .00078 		<	.8 .8 .8 .6 .16 .2 .2 .46 .28		<	.0666 .12 1.2 .53 .98 169 8 .31 .00086 .15 .00081 .02			.066 .12 .068 .033 .11 8 8 8 .017 .00086 .012 .00081 .00078																									
Total Organic Carbon 293000 D 283000 76900 602000 109000	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Diesel Tplagas VOLATILE ORGANICS Acetone Chlorobenzene Dichloromethane Tetrachloroethene Toluene Trichlorofluoromethane		 3 .6 7 3 6 75.5 81.5 2 .004 	D D D D D D D D D D D D D D D D D D D	 < .7 < 1 5 2 5 < 8 < .017 .00086 .012 .00081 .00078 .0059 		<pre>< .00 < .00 < .00 < .00 < .00 .00 .00 .00 .00 .00 .00 .00 .00 .00</pre>	8 8 8 8 8 8 8 8 8 8 8 8 8 8		<	.0504 .066 .12 1.2 .53 .98 .009 8 .31 .00086 .15 .00081 .02 .0059		<u> </u>	.066 .12 .068 .033 .11 .017 .00086 .012 .00081 .00078 .0059																									
	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Diesel Tphgas VOLATILE ORGANICS Acetone Chlorobenzene Dichloromethane Tetrachloroethene Toluene Trichlorofluoromethane OTHER		 3 6 7 3 6 75.5 81.5 2 <.004 <.004 <.004 <.004 <.004 <.004 <.004 	D D D D D D D D D D D D D D D D D	 < .7 < 1 5 2 5 < 8 < 8 < .017 < .00086 < .012 < .00081 < .00078 < .0059 		 .00 .00 .01 .01 .01 .01 .01 .01 .01 .02 .01 .01	8 8 8 8 8 8 8 8 8 8 8 8 8 8		<	.0666 .12 1.2 .53 .98 .00086 .15 .00081 .02 .0059		<u> </u>	.066 .12 .068 .033 .11 .11 .0038 .017 .00086 .012 .00081 .00078 .0059																									
Total Petroleum Hydrocarbons 212 D 186 < 27.6 1860 355	Chrysene Fluoranthene Phenanthrene Pyrene TPH BY GC Dicsel Tphgas VOLATILE ORGANICS Acetone Chlorobenzene Dichloromethane Tetrachloroethene Toluene Trichlorofluoromethane OTHER Total Organic Carbon		 3 6 7 3 6 75.5 81.5 81.5 2 <.004 <.004 <.004 <.004 <.003 293000 	D D D D D D D D D D D D D D	 < .7 < 1 5 2 5 < 8 < 8 < .00086 < .012 < .00081 < .00078 < .0059 		 	8 8 8 16 12 46 28 5 00		<	.0666 .12 1.2 .53 .98 169 8 .00086 .15 .00081 .02 .0059 602000		<u> </u>	.066 .12 .068 .033 .11 .033 .11 .033 .017 .00086 .017 .00086 .012 .00081 .00078 .0059 .0059																									

Site ID:		57D-95-05X	57D-95-05X	57D-95-06X	57D-95-06X	57D-95-07X
Field Sample Number:	200012-210	DX570500	DX570502	DX570600	DX570602	DX570700
Lab Sample Number:	Devens	DV4S*191	DV4S*192	DV4S*193	DV4S*194	DV4S*195
Sample Date:	Background	09/13/95	09/13/95	09/12/95	09/12/95	09/12/95
Depth:	Concentrations	0	2	0	2	0
Units:	UGG	UGG	UGG	ŬGG	UGG	UGG
METALS						
Aluminum	18000	15000	4770	15900	2300	9640
Arsenic	19	28	12.1	80	6.2	110
Barium	54	70	30.6	124	< 5.18	159
Beryllium	0.81	< .5	< .5	< .5	< .5	< .5
Cadmium	1.28	2.33 -	<7	< .7	< .7	< .7
Calcium	810	2170	2470	10800	894 1	18400
Chromium	33	43.2	98,8	48.9	10.9	< 4.05
Cobalt	4.7	6.91	3.11	20.9	< 1.42	20:4
Copper	13.5		8.31	42.3	2.17	36.1
Iron	18000	18900	5440	27800	3180	29700
Lead	48	188	27	281	18	170
Magnesium	5500	3880	1170 -	4480	778	2990
Manganese	380	123	247	1240	38.9	3940
Mercury	14.6	< .05	< .05	.36	< .05	< .05
Nickel	2400	25.7	10.3	42.2	3.72	36.3
Potassium		1240	351	1190	173	< 100
Selenium	0.086	Contract of the second second	.776	2.41	.649	< .25
Sodium	131		688	2090	434	2380
Vanadium	32.3	28.4	< 3.39	40/3	< 3.39	< 3.39
Zinc	43.9	129	19.6	432	20.5	434
PESTICIDES/PCBS						•
4,4'-ddd		.0258 C	< .00826	.44 C	.089 C	.21 C
4,4'-dde		< .00765	< .00765	.162 C	.0222 C	.086 C
4,4'-ddt		.0363 C	< .00707	.0759 C	< .00707	< .00707
Dieldrin		.0183 C	< .00629	< .00629	< .00629	< .00629
Pcb 1260		.301 C	< .0804	< .0804	< .0804	< .0804
SEMIVOLATILE ORGANICS	S	- · · · -				
Benzo[k]fluoranthene		< 1	< .3	< .7	< .3	3
Chrysene		< 2	< .6	< 1	< .6	< .6
Fluoranthene		< 1	< .3	5	< .3	6
Phenanthrene		< .7	< .2	< .3	< .2	3
Рутепе		< .7	< .2	5	.4	6
TPH BY GC						
Diesel		52.5	< 8	62.1	< 8	114
Tpligas		< 8	< 8	< 8	< 8	150 .
VOLATILE ORGANICS					·	_ 1 # 1111
Acetone		.071	.041	.2	< .017	< .017
Chlorobenzene		< .00086	< .00086	< .00086	< .00086	< .00086
Dichloromethane		< .012	< .012	< .012	< .012	< .012
Tetrachloroetliene		< .00081	< .00081	< .00081	< .00081	< .00081
Toluene		.0065	.0019	.0098	< .00078	< .00078
Trichlorofluoromethane	<u> </u>	.02	< .0059	< .0059	.011	.076
OTHER			· · · · · ·			
Total Organic Carbon		84900	60900	304000	9820	187000
Total Petroleum Hydrocarbons		3170	153	1070	< 27.5	< 27.5

Site ID:		57D-95-07X	57D-95-08X	57D-95-09X	57D-95-10X
Field Sample Number:	Sector Sector	DX570702	DX570800	DX570900	DX571000
Lab Sample Number:	Devens	DV4S*196	DV4S*197	DV4S*198	DV4S*199
Sample Date:	Background	09/12/95	09/13/95	09/12/95	09/13/95
Depth:	Concentrations	2	0	0	0
Units:	UGG	UGG	UGG	UGG	UGG
METALS					
Alununum	18000	3470	11800	13700	8130
Arsenic	19	77	69	88	66.2
Barium	54	28.4	107	138	99.8
Beryllium	0.81	< .5	< .5	< .5	< .5
Cadmium	1.28	< .7	< .7	< .7	< .7
Calcium	810	6400	10300	13700	13400
Chromium	33	< 4.05	39.1	40.9	< 4.05
Cobalt	4.7	< 1.42	21.7	25.8	15.1
Copper	13.5	5.25	33.4	48.6	34.2
Iron	18000	5890	24700	30400	15500
Lead	48	20.2	223	215	170
Magnesium	5500	1120	3610	3830	2240
Manganese	380	470	1640	3000	2040
Mercury	14.6	< .05	.241	< .05	< .05
Nickel	2400	< 1.71	36.8	42.9	27.7
Potassium		< 100	989	1010	769
Selenium	0.086	1.19	2.43	3.1	< .25
Sodium	131	856	1390	2010	2110
Vanadium	32.3	< 3.39	35.3	35.9	29.5
Zinc	43.9	39.2	339	468	251
PESTICIDES/PCBS					Saury and do all'And an antificiant relation 1.
4,4'-ddd		< .00826	.49 C	.29 C	.22 C
4,4'-dde		< .00765	.18 C	.14 C	.1 C
4,4'-ddt		< .00707	.12 C	.0667 C	.053 C
Dieldrin		< .00629	< .00629	< .00629	< .00629
Pcb 1260		< .0804	< .0804	< .0804	< .0804
SEMIVOLATILE ORGANICS	3				
Benzo[k]fluoranthene		.35	2	< .3	< .3
Chrysene		.46	< .6	< .6	< .6
Fluoranthene		.83	4	3	< .3
Phenanthrene		.38	2	1	< .2
Pyrene		.74	4	3	2
TPH BY GC					
Diesel		< 8	51.4	68	< 8
Tphgas		46.6	71.4	107	117
VOLATILE ORGANICS					
Acetone		.12	.1 X	< .017	.1 X
Chlorobenzene		< .00086	< .00086	< .00086	< .00086
Dichloromethane		< .012	< .012	< .012	< .012
Tetrachloroethene		< .00081	< .00081	< .00081	< .00081
Toluene		< .00078	< .00078	< .00078	.0066
Trichlorofluoromethane		< .0059	< .0059	< .0059	< .0059
OTHER					
Total Organic Carbon		92900	265000	226000	462000
Total Petroleum Hydrocarbons		106	277	< 27.6	273

Notes: C = Detection confirmed D = Duplicate analysis M = The high spike recovery is high

= Exceeds background concentrations X = Analyte exceeds upper reporting limit

TABLE 7-18 1998 SEDIMENT FIELD AND OFF-SITE ANALYTICAL RESULTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

			Area 2			Area 3					
				57D-98-01X	57D-98-02X	57D-98-03X	57D-98-04X	57D-98-05X	570-98-06X	57D-98-07X	57D-98-08X
				DX570100	DX570200	DX570300	DX570400	DX570500	DX570600	DX570700	DX570800
Parm	Method	Analyte	Units:	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98
Volatile Organics										· · · · · · · · · · · · · · · · · · ·	
	LM19	Acetone	µg/g	LT .017	LT .017	LT .017	.21	.057	.13	.17	.19
	LM19	Benzene	µg/g	LT .0015	.007	LT .0015	.037				
	LM19	Chlorobenzene	µg/g	LT .00086	LT .00086	LT .00086	LT .00086	.019	.013	LT .00086	.0031
	LM19	Toluene	hð/ð	LT .00078	LT .00078	L.T .00078	LT .00078	.0018	.0047	LT .00078	.0048
	LM19	Tetrachloroethene	µg/g	.078	.01	L.T .00081	LT .00081	LT .00081	LT .00081	LT.00081	LT .00081
	LM19	Trichloroethylene	µg/g	LT .0028	.027	LT .0028	L.T .0028				
	LM19	Xylenes	µg/g	LT .0015	.011						
Semivolatile Organics			1								
	LM18	1,2-dichlorobenzene	µg/g	Lĩ .11	LT .11	LT .11	LT .11	LT .11	.39	LT .11	LT .11
	LM18	1,4-dichlorobenzene	hð/ð	LT .098	LT .098	LT .098	LT .098	1	.43	L.T .098	LT .098
	LM18	Benzo[b]fluoranthene	<u>hð\ð</u>	LT .21	LT .21	LT .21	LT .21	.49	LT .21	LT .21	LT .21
	LM18	Benzo[k]fluoranthene	hð\ð	.35	.65	LT .066	LT .066	19	.2	.28	LT .066
	LM18	Chrysene	_µg/g	53	1.2	LT .12	LT .12		LT .12	LT .12	LT .12
	LM18	Fluoranthene	<u>µg/g_</u>	.86	2	.82	LT .068	.47	.47	.65	.17
	LM18	Naphthalene	<u>µg/g</u>	LT .037	LT .037	LT .037	LT .037	.13	.53	LT .037	LT .037
	LM18	Phenanthrene	µg/g	.52	1.1	.48	LT .033	.19	.27	.37	.085
	LM18	Pyrene	ug/g	.79	1.7	.72	.2	.46	.4	.56	.16
Pesticides/PCBs				t							
	LH10	Dieldrin	µg/g	LT .00629	LT .00629	.046 c	LT .00629	LT .00629	LT .00629	LT .00629	LT .00629
	LH10	4,4'-DDD	<u>_µg/g</u>	LT .00826	.091 c	.0418 c	LT .00826	.048 c	.15 c	.0586 c	LT .00826
	LH16	Pcb 1260	_µg/g_	LT .0804	LT .0804	LT .0804	LT .0804	.84 c	LT .0804	LT .0804	LT .0804
Other	······		<u> </u>	<u>[</u>							
	9060	Total Organic Carbon	µg/g_	121000	177000	149000	210000	41200	97600	97000	38400
	9071	Total Petroleum Hydrocarbons	hð/ð	103	452	185	246	3540	160	200	109
Metals			<u> </u>	<u> </u>							
	JS16	Barium	<u>hð\ð</u>	30	LT 5.18	LT 5.18	59.8	37.7	25.2	26.4	16.1
	JS16	Copper	<u>_hð\ð</u>	14.3	8.69	LT .965	4.97	11.2	2.72	LT .965	LT .965
	JS16	Manganese	<u>hð\ð</u>	269	40.1	48.6	459	140	156	29	155
	JS16	Lead	_hð\d	43.9	88.9	LT 10.5	LT 10.5	64.6	33.6	LT 10.5	LT 10.5
	JS16	Zinc	<u>_h0\0</u>	LT 8.03	LT 8.03	LT 8.03	LT 8.03	90.8	LT 8.03	LT 8.03	LT 8.03
	J301	Arsenic	hđ\d	220	12.1	10.4	6.76	37.1	<u>37</u>	15.8	3.19
	J301	Selenium	μg/g	2.98	7.74	3.44	1.82	0.716	1.8	1.27	LT 0.250
VPH Ranges (µg/g)			<u></u>		·····						
		n-C5 to n-C8 Aliphatic	hð/ð	<5.2	<9.3 j	<7.6 j	<8.0	<2.7	3.3	<2.2 j	<1.8
		n-C9 to n-C12 Aliphatic	µg/g	<5.2	<9.3	<7.6	<8.0	4.2	5.6	<2.2 j	<1.8
		n-C9 to n-C10 Aromatic	µg/g	<5.2	<9,3	<7.6	<8.0	<2.7	4.3	<2.2 j	<1.8
EPH Ranges (µg/g)											
		n-C9 to n-C18 Aliphatic	p/g/	<130 j	<200 j	<140 j	<160	<70 j	<63 j	<69 j	<50 j
		n-C19 to n-C36 Aliphatic	µg/g	<130	<200	<140	<160	630	<63	<69	<50
		n-C11 to n-C22 Aromatic	p/g/	<130	<200	<140	<160	280	<63	<69	<50
On-Site TPH (µg/g-dry)			hð/ð	2500	<31000	<1800	<1500	5500	<380	5500	<390

Notes:

j = estimated

LT = less than

C = analysis confirmed

exceeds established Devens background concentration

.

Site 1D:		57D-95-03	x	57D-95-03X	57D-95-04X	57D-95-04X	57D-95-05X
Field Sample Number:		WD5703X2	X	WX5703XX	WX5704XX	WX5704XX	WX5705XX
Lab Sample Number:	Devens 👘	DV4W*43	Ζ	DV4W*202	DV4F*203	DV4W*203	DV4F*204
Sample Date:	Background	09/13/95		09/13/95	09/14/95	09/14/95	09/13/95
Depth:	Concentrations	0		0	0	0	0
Units:	UGG	UGL	8446 E. M.	UGL	UGL	UGL	UGL
METALS							
Aluminum	18000	< 141	D	< 141	< 141 F	15100	< 141 F
Arsenic	19	4.69	D	5.12	< 2.54 F	41.6	8.85 F
Barium	54	12.5	D	13.7	20.9 F	169	43.1 F
Cadmium	1.28	< 4.01	D	< 4.01	< 4.01 F	24.6	< 4.01 F
Calcium	810	23300	<u> </u> D	25400	11800 F	28700	<u>19100</u> F
Chromium	33	< 6.02	D	< 6.02	< 6.02 F	35.8	< 6.02 F
Copper	13.5	< 8.09	D	24	< 8.09 F	375	< 8.09 F
Iron	18000	687	D	512	549 F	17600	17200F
Lead	48	< 1.26	D	< 1.26	2.28 F	690	< 1.26 F
Magnesium	5500	3470	D	3760	1050 F	4930	1180 F
Manganese	380	119	D	123	64.2 F	252	483 F
Mercury	14.6	< .243	D	< .243	< .243 F	.242	< .243 F
Potassium		1870	D	1410	2430 F	- 3840	1710 F
Sodium	131	18700	D	20000	<u>56900</u> F	60900	15800 F
Vanadium	32.3	< 11	D	< 11	< 11 F	. 72.3 .	< 11 F
Zine	43.9	< 21.1	D	< 21.1	< 21.1 F	712	58.4 F
SEMIVOLATILE ORGANICS							
Phenanthrene		< .5	D	< .5		.52	
Bis(2-cthylhexyl) Phthalate		< 4.8	D	< 4.8		24	
VOLATILE ORGANICS							
*1,2-dichloroethylenes (cis And Trans)		< .5	D	< .5		< .5	
Dichloromethane		< 2.3	D	2.4		< 2.3	[
Tetrachloroethene		< 1.6	D	< 1.6		< 1.6	
Toluene		< .5	D	< .5		< .5	
Trichloroethylene		< .5	D	< .5		< .5	
WET CHEMISTRY							1
Alkalinity		35000	D	34000		13000	1
Chloride		44000	D	44000		100000	-
Nitrite, Nitrate-non Specific		129	D	137		< 10	
Nitrogen By Kjeldahl Method		1430	D	229	[16000	
Phosphate		118	D	24.8		1000	
Sulfate		13000	D	13000		13000	
Total Dissolved Solids		153000	D	159000		234000	
Total Hardness		95000	D	132000		104000	
Total Suspended Solids		108000	ñ	47000		504000	
Com ouspended conds		100000	2	1000		501000	
				1			
UTHER Text Detections the descent		160	N	160		1 004	
Lotal Petroleum Hydrocarbons		< 109		S 108		924	


TABLE 7-19 RI SURFACE WATER OFF-SITE ANALYTICAL RESULTS AOC 57 REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Site ID: Field Semple Number:		57D-95-05X	57D-95-06X	57D-95-06X WX5706XX	57D-95-07X WX5707XX	57D-95-08X WX5708XX
Lab Sample Number:	Devens	DV4W*204	DV4F*205	DY4W*205	DV4W*206	DV4F*207
Sample Date:	Background	09/13/95	09/12/95	09/12/95	09/12/95	09/13/95
Denth:	Concentrations	0	0	0	0	0
Units:	UGG	UGL	UGL	UGL	UGL	UGL
METALS	1				·	
Aluminum	18000	185	< 141 F	< 141	244	< 141 F
Arsenic	19	9.17	3.52 F	4.8	6.29	4.37 F
Barium	54	41.3	12.6 F	14.4	16.7	11.9 F
Cadmium	1.28	< 4.01	< 4.01 F	< 4.01	< 4.01	< 4.01 F
Calcium	810	18400	24000 F	25700	23700	<u>24100</u> F
Chromium	33	< 6.02	< 6.02 F	< 6.02	< 6.02	< 6.02 F
Copper	13.5	< 8.09	< 8.09 F	< 8.09	< 8.09	< 8.09 F
Iron	18000	14600	194 F	592	1040	254 F
Lead	48	< 1.26	< 1.26 F	< 1.26	2.93	< 1.26 F
Magnesium	5500	1290	3550 F	1.2.2.3770.2.2.32	3500	3610 F
Manganese	380	433	156 F	177	289	107 F
Mercury	14.0	< .243	< .243 P	< .243	< .243	< .243 F
Polassium		1010	1490 F	1490	1320	1700 P
Sodium	131	11		20000	20300	11 F
Vanaoium Zina	32.3	100		21.1	211	
2000	43.9	103	21.1 1	21.1	21.1	21.1 1
SEMIVOLATILE ORGANICS	<u> </u>				1	1, , ,
Phenanthrene		< .5		< .5	< .5	
Bis(2-cthylhexyl) Phthalate		< 4.8		< 4.8	< 4.8	ł
	1		1		<u> </u>	<u> </u>
VOLATILE ORGANICS	<u>, </u>		T	1		1
*1,2-dichloroethylenes (cis Aud Trans)		26		< .>	< .5	
Dichloromethane		1< 2.3		2.7	4.1	
Tetrachioroeulene		1.8		- 1.0	< 1:0	
Trislametholene		~ *5				
1 ricilloroechylene						
WET CHEMISTRY	· · · · · · · · · · · · · · · · · · ·	J			· · · · · · · · · · · · · · · · · · ·	
Alkalinity		33000		36000	32000	
Chloride		25200	9	44000	44000	1
Nitrite, Nitrate-non Specific		< 10		142	130	
Nitrogen By Kjeldahl Method		714	1	352	886	
Phosphate		70		24.8	79.1	
Sulfate		11000		13000	13000	1
Total Dissolved Solids		125000		160000	156000	
Total Hardness		106000		110000	104000	
Total Suspended Solids		47000		9000	151000	
	1		<u>l</u>			
OTHER				160	123	· · · · · ·
Total Petroleum Hydrocarbons	I	247	1	< 108	IS 173	l

TABLE 7-19 RI SURFACE WATER OFF-SITE ANALYTICAL RESULTS AOC 57 REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

· Site ID:		57D-95-08X	57D-95-09X	57D-95-10X	57D-95-10X
Field Sample Number:		WX5708XX	WX5709XX	WX5710XX	WX5710XX
Lab Sample Number:	Devens	DV4W*207	DV4W*208	DV4F*209	DV4W*209
Sample Date:	Background	09/13/95	09/12/95	09/13/95	09/13/95
Depth:	Concentrations	0	0	0	0
Units:	UGG	UGL	UGL	UCL	UGL
METALS					
Aluminum	18000	< 141	156	< 141 F	158
Arsenic	19	5.86	5.01	3.41 F	4.05
Barium	54	12.1	13.2	11.7 F	12.9
Cadmium	1.28		< 4.01	< 4.01 F	< 4.01
Calcium	810	24200	21600	22300 F	22000
Chronium	33	< 6.02	< 6.02	< 6.02 F	< 6.02
Copper	13.5	< 8.09	< 8.09	< 8.09 F	< 8.09
Iron	18000	691	607	230 F	620
Lead	48	< 1.26	1.52	< 1.26 F	2.49
Magnesium	5500	3640	3130	3260 F	3220
Manganese	380	141	182	83.4 F	123
Mercury	14,6	< .243	< .243	< .243 F	< .243
Potassium		1620	1570	<u>1750</u> F	1490
Sodium	131	19000	19000	. 19600, F	19300
Vanadium	32.3	< 11	< 11	< 11 F	< 11
Zinc	43.9	< 21.1	< 21.1	< 21.1 F	< 21.1
SEMIVOLATILE ORGANICS				· ····································	· · · · · · · · · · · · · · · · · · ·
Phenanthrene		< .5	< .5		< .5
Bis(2-ethylhexyl) Phthalate		< 4.8	< 4.8		< 4.8
VOLATILE ORGANICS		······································			······································
*1,2-dichloroethylenes (cis And Trans)		< .5	< .5		< .5
Dichloromethane		4.2	2.3		< 2.3
Tetrachloroethene		< 1.6	< 1.6		< 1.6
Toluene		.58	< .5		< .5
Trichloroethylene		< .5	< .5		< .5
WET CHEMISTRY			r		······································
Alkalinity		36000	33000		31000
Chloride		44000	44000		44000
Nitrite, Nitrate-non Specific		122	152	1	146
Nitrogen By Kjeldahl Method		448	276		< 183
Phosphate		26.9	29.5		18,8
Sulfate		13000	13000		13000
Total Dissolved Solids		163000	150000		150000
			149000 D		
Total Hardness		101000	85000		93000
Total Suspended Solids		< 4000	8000		4000
			11000 D		
OTHER					
Total Petroleum Hydrocarbons		< 191	< 169	I	< 178

Notes:

D = Duplicate analysis F = Filtered sample

TABLE 7-201998 SURFACE WATER AND FIELD OFF-SITE ANALYTICAL RESULTSAOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

.

				·		Are	ea 2			Are	ea 3
				57W-98-01X	57W-98-01X	57W-98-02X	57W-98-02X	57W-98-03X	57W-98-03X	57W-98-04X	57W-98-04X
			1: :: ::	WX570100	WX570100.	WX570200	WX570200	:::WX570300 :::	WX570300	WX570400	WX570400
Parm	Method	Analyte	Units	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98
Wet Chemistry											
	1602	Total Suspended Solids	µg/L	4000		10500000		2430000			15800000
Volatile Organics			{:::::::::::::::::::::::::::::::::::::							<u> </u>	
	UM20	Chloroform	µg/L	LT .5		.72		LT .5			LT .5
	UM20	Tetrachloroethene	µg/L	2.6		LT 1.6		LT 1.6			LT 1.6
	UM20	Trichloroethene	_µg/L_	0.6		LT .5		LT .5			LT .5
	UM20	Chlorobenzene	<u>μg/L</u>	LT .5		LT .5		LT .5			LT .5
	UM20	Carbon Disulfide	_ug/L_	L.T .5		1.1		LT .5			LT .5
	UM20	Toluene	µg/L	LT .5		LT .5		1.1		l	LT .5
Semivolatile Organics			<u> </u>		<u> </u>	• • • • • • • • • • • • • • • • •			<u></u>	£	
	UM18	Benzo[k]fluoranthene	ug/L	LT .87		LT .87		LT .87		ļ	LT .87
Metals			<u> </u>							<u> </u>	
	S303	Arsenic	_µg/L_	96.2	5.14 f	198	6.86 f	90.1	4.91	24 1	70.8
	<u>\$303</u>	Antimony	/L	LT 1.00	LT 1.00 f	LT 1.00	LT 1.00 f	LT 1.00	LT 1.00 f	LT 1.00 (LT 1.00
	SS18	Barium	_μg/L_	254	20_f	553	9.6 1	323	10.2 1	10 1	267
	SS18	Copper	<u>µg/L</u>	62.2	LT 5_f	156	LT 5 1	60.4	LT 5 1	LT 5 f	44.1
	S303	Lead	<u>_µg/L</u>	37	1.96 f	71.4	1.43 f	35.5	2.06 1	1.95 1	<u>- 32.9</u>
	SS18	Manganese	<u>µg/∟</u>	2690 RJ	540 f RJ	3680 RJ	97.7 f	1640 RJ	69,2 1	282 f RJ	1650 RJ
	<u>S303</u>	Selenium	<u>µg/L</u>	LT 2.00	LT 2.00 f	2.35	LT 2.00 f	LT 2.00	LT 2.00 f	LT 2.00 f	LT 2.00
	SS18	Zinc	hð/r	138	LT 35.8 f	363	LT 35.8 f	256	LT 35.8 1	LT 35.8 f	340
VPH Ranges (µg/L)			{. : <i>.</i> :,								
		n-C5 to n-C8 Aliphatic	µg/L	<20		<20		<20			<20
		n-C9 to n-C12 Aliphatic	µg/L	<20		<20		<20			<20
		n-C9 to n-C10 Aromatic	µg/L	<20 j		<20 j		<20 j			<20
EPH Ranges (µg/L)										İ	
[···········		n-C9 to n-C18 Aliphatic	µg/L	<500		<500		<500			<500
		n-C19 to n-C36 Aliphatic	µg/L	750		1700		1400			1000
		n-C11 to n-C22 Aromatic	µg/L	380		1400		610			430
On-Site TPH (mg/L)			{·····	j						l	
			mg/L	<50		<50		<50			<50

Notes:

f = filtered

sample

j = estimated

LT = less than

J = low spike recovery was low

R = rejected

= exceeds established Devens background concentration

TABLE 7-20 1998 SURFACE WATER AND FIELD OFF-SITE ANALYTICAL RESULTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

							Are	ea 3	•		
				57W-98-05X	57W-98-05X	57W-98-06X	57W-98-06X	57W-98-07X	57W-98-07X	57W-98-08X	57W-98-08X
				WX570500	:: WX570500	:::WX570600:::	WX570600	WX570700	WX5707.00	WX570800	WX5708D0
Parm	Method	Analyte	Units	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98	5/21/98
Wet Chemistry											
	1602	Total Suspended Solids	µg/L	3240000		3330000		4540000		6170000	
Volatile Organics											
	UM20	Chloroform	µg/L	LT .5		LT .5		LT .5		LT .5	[
	UM20	Tetrachloroethene	µg/L	LT 1.6		LT 1.6		LT 1.6		LT 1.6	
	UM20	Trichloroethene	μg/L	LT .5		LT .5		LT .5		LT .5	
	UM20	Chlorobenzene	µg/L	4.6		LT .5		LT .5		LT .5	
	UM20	Carbon Disulfide	µg/L	.58		LT .5		LT .5		LT .5	
	UM20	Toluene	µg/L	1.6		LT .5		LT .5		.59	
Semivolatile Organics										<u> </u>	<u> </u>
	UM18	Benzo[k]fluoranthene	µg/L	LT .87				LT .87		.94	
Metals.										<u> </u>	·····
	S303	Arsenic	_µg/L_	153	53.4 1	25.3	<u>6.53 f</u>	5.55	3.7 1	12.5	12.5 1
	S303	Antimony	µg/L	5.62	LT 1.00 I	2.07	LT 1.00 f	LT 1.00	LT 1.00 I	1.98	LT 1.00 f
	SS18	Barium	hð/r	• 278	22,8 1	180	<u>7.6 f</u>	42.8	5.2	110	21.6 (
	SS18	Copper	_µg/L_	27.6	LT5 i	26	LT5 f	LT 5	LT 5 1	19.2	LT 5 1
	S303	Lead	_µg/L_	97.4	LT 1.00 1	<u>185 - 185</u>	LT 1.00 f	27.8	LT 1.00	120	1.73 i
	SS18	Manganese	μg/L	1370 RJ	892 f RJ	1350 RJ	155_f	92.8	37.6	2600 RJ	2050 f RJ
	S303	Selenium	µg/i,	2.05	LT 2.00 I	2,53	LT 2.00 f	L.T 2.00	LT 2.00 I	LT 2.00	LT 2.00 f
	SS18	Zinc	µg/L	445 Add 145	LT 35.8 f		LT 35.8 f	LT 35.8	LT 35,8 1	80.6	LT 35.8 f
VPH Ranges (µg/L)	· · · · · · · · · · · · · · · · · · ·									[
		n-C5 to n-C8 Aliphatic	µg/L	<20		<20		<20		<20	
		n-C9 to n-C12 Aliphatic	µg/L	<20		<20		<20		<20	
		n-C9 to n-C10 Aromatic	µg/L	25 j		<20 j		<20 j		<20 j	
EPH Ranges (µg/L)			• • • • • • • •								
		n-C9 to n-C18 Aliphatic	μg/L	<530		<500		<500		<500	
		n-C19 to n-C36 Aliphatic	μg/L	<530	·	<500		<500		1100	
[]····		n-C11 to n-C22 Aromatic	µg/L	400		300		360		650	
On-Site TPH. (moll.)											
			mg/L	<50		<50	<u>, , , , , , , , , , , , , , , , , , , </u>	<50		<50	· · · · · · · · · · · · · · · · · · ·

Notes:

f = filtered

sample

j = estimated

LT = less than

J = low spike recovery was low

R = rejected

entropy and established Devens background concentration

T/ 21 CONFIRMATOK PLING RESULTS AOC 57 AREA 3 AMUNIOVAL ACTION AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

SAMPLE IO	MCP	MCP	RISK	RISK	EX57W01X	EX57W02X	E057W02X	EX57W03X	EX57W04X	EX57W05X	EX57W06X	EX57W07X	EX57W08X	EX57W09X	EX57W10X
	5-1/GW-1	S-2/GW-3	BASED	BAŞED	2.5 ft bgs	3 ft bgs	3 ftbgs	3 R bgs	3 ft bgs	3 ft bgs	5 ft bgs	5 ftbgs	5 ft.bgs	4 ft bgs	3 ft bgs
DATE COLLECTED			SURFACE	SUBSURFACE	25-Mar-99	25-Mar-99	25-Mar-99	25-Mar-99	25-Mar-99	25-Mar-99	25-Mar-99	25-Mar-99	25-Mar-99	16-Apr-99	16-Apr-99
	(uo/a)	(ua/a)	(uala)	(µq/q)	The second			ALSO NON	Sold Party of the						
VPH (wala)	0.0.0				257 258 258			NET 2 NEW POST	WITCH STREET						í
p-C5 to p-C8 Aliohatic	100	500			<20	<23	<20		420	<19	<18	<16	<18	<15	<15
n-C9 to n-C12 Alionatic	1000	2500			-4.9	<<5.8	<4.9	<4.8	<4.9	<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
n-C9 to n-C10 Aromatic	100	500			4.9	<5.8J	6.8J	-4.8	<4.9	<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
Benzene	10	60			<2.5	<2.9	<2.4	<2.4	-24	24	<2.3	<2.3	<2.2	<1.8	<1.9
Ethyberrene	60	80			25	<2.9	<2.4	- <24	-24	<2.4	<2.3	<2.3	<2.2	<1.8	<1.9
m n-Xviene	500*	1000*			<9.9	<12	<9,8	<9,5	<9.8	<9.5	<9,3	<9.1	<8,9	<7,4	<7.6
MTBE	0.3	200			-7.A	<6.8	<7.4	<7,1	<7.3	<7.1	<7.0	<6.8	<6.7	<5.6	<5.7
Naobthaicoe	4	1000			<4.9	<5.8	<4.9	<4.8	<4 9	<4.7	<4.6	<4.5	<4,5	<3,7	<3.8
n-Xvene	500*	1000*			-4.9	<5.8	<4,9	<4.8		<4.7	<4.6	<4.5	<4.5	<3.7	<3.8
Tokepe	90	1000			<7.4	<5.5	<7.4	<7.1	-7.3	<7.1	<7.0	<6.8	<6.7	<5.6	<5.7
FPH (uala)					NE STREET WEIGHT			Sold Shares	THE REAL PROPERTY IN						
n-C9 in n-C18 Aliobatic	1000	2500	NA	NA	50	<7.1	<7.4	11	61	<6.4	<6.4	9	< 6.3	<6.3	<6.9
o-C19 to o-C36 Aliobatic	2500	5000	20000	20000	660	<7.1	<11	420	1700	<6,4	<20	440	<10	<6.3	<6,9
p-C11 to p-C22 Aromatic	200	2000	5000	10000	64	<19	<20	200	380	<17	<17	37	<17	<17	<18
2-Melbynaphthalene	4	1000			-1.8	<1.8	<1.8	<17	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Acenantibene	. 20	2000			<1.8	<1.8	<1.8	<1.7	<1.8	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Acenanbilitylene	100	1090			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1,6	<1,6	<1.6	<1.7
Anthracene	1000	2500			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Berzo(a)apibracene	0.7	1			<1.8	<1.8	<1.8	<1.7	<1.5	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzo(a)ovrene	0.7	0.7			<1.8	<1.8	<1.8			<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Renzo(h)/kmcadhene	07	1			<1.8	<1.8	<1.8	<17	<1.8	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Benzolo h Dipeodene	1000	2500			<1.8	<1.8	<1.8	<1.7	4.5	<1,6	<1.6	<1.6	<1.5	<1.6	<1.7
Benzolkilluorapihene	7	10			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1,6	<1.6	<1,6	<1,6	<1.7
Choisene	7	10			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1,6	<1.6	<1.6	<1,7
Obenzo(a blazilyacene	07	07			<1.8	<1.8	<1.8	<17		<1.5	<1.6	<1.6	<1.6	<1.6	<1.7
Ekoranthene	1000	600			<1.8	<1.0	<1.8	<1.7	<1.8	<1.6	<1.6	<1.6	<1.5	<1.6	<1.7
Ekorene	400	1000			<1.8	<1.8	<1.8	<1.7	<1.0	<1.6	<1.6	<1.6	<1.6	<1,6	<1.7
Indeno(1.2.3-cd)ovrepe	0.7	1			<1.8	<1.8	<1.8	<17	×1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Nanhthaiene	4	1000			≺1.8 J	<1.8J	<1.8J	<1.7J	<1.6J	<1.6.	<1,6J	<1.ธีป	<1.6J	<1.6J	<1.7
Phenantbrene	700	100			<1.8	<1.8	<1.8	<1.7	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
Pyrene	700	2000			<1.8	<1.8	<1,8	-17	<1,6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.7
PCBs (unfa)					Section 2			1000 S 100 S 100 S	STORE STREET						
PC8-1016	2	2	2	4	-0.020	<0.020	<0.020	<0.020	×0.019	<0.019	<0.019	<0.019	<0.017	<0,017	<0.020
PCB-1221	2	2	2	4	<0.040	<0.040	<0.040	<0.040	<0,036	<0.036	<0,036	<0.036	<0,033	<0.033	<0.040
PCB-1232	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PC8-1242	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PC8-1248	2	2	2	4	<0.020	<0.020	<0.020	<0,020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1254	2	2	2	4	<0.020	<0.020	<0.020	<0.020	<0.019	<0.019	<0.019	<0.019	<0.017	<0.017	<0.020
PCB-1260	2	2	2	4	1.3	<0.020	<0.020	2.8	0.43	<0,019	0,039	0,88	<0.017	0.025	<0.020
PESTICIDES (ug/g)					WWWWWWWW			N. Marking Street, Solar	Carl Strange						
ainha-BHC					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0,0019	<0.0019	<0,0017	<0.0017	< 0.002
gamma-BHC (Lindage)					<0.020	< 0.002	<0,002	⊲0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002.1
Hentachor	0.1	0.2			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017	<0.002
Akirka	0.03	0,04			<0.020	<0,002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017	<0.002
beta-BHC					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002.
delta-BHC					<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0,0019	<0.0019	<0.0017	<0.0017	<0.002
Heptachior epoxide	0.06	0.09			. <0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002.J
Endosutan I	20	0.05			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0.0017	<0.0017J	<0.002.J
gamma-Chiordane	1	2			<0.020	<0.002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0,0017	<0.0017.J	<0.002J
alpha-Chiordane	1	2			-0.020	<0,002	<0.002	<0.020	<0.073	<0.0019	<0.0019	<0.0019	<0,0017	<0.0017J	<0.002J
4,4'-DDE	2	2			<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0.0036	< 0.0033	< 0.0033	<0.004
Diektrin	0.03	0.04			0.042.1	<0.004	<0.004	<0.040	<0.140	<0,0036	<0.0036	<0.0036	< 0.0033	<0.0033J	<0.0043
Endrin	0,6	1			<0.040	<0.004	< 0.004	<0.040	<0.140	<0.0036	<0,0036	<0,0036	<0,0033	<0,0033J	<0.004J
4,4'-DDD	2	3			0.2J	<0,004	<0,004	<0.040	1.8.	<0.0036	<0.0036	<0.0036	< 0.0033	<0.0033J	<0.004J
Endosulfan II					<0.040	<0.004	<0.004	<0.040	<0.140	<0,0036	<0.0036	<0,0036	< 0.0033	<0.0033J	<0,004J
4,4'-DDT	2	2			<0,040	< 0.004	<0.004	<0,040	<0.140	<0.0036	<0.0036	<0.0036	< 0.0033	<0.0033J	<0.004J
Endrin aldehyde					<0.040	<0.004	<0,004	⊲0.040	<0.140	< 0.0036	<0.0036	<0.0036	< 0.0033	<0.0033	<0.004
Endosutian sullate					<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	<0,0036	< 0.0033	<0.0033J	<0.004J
Methoxychlor	100	30			<0.200	<0.020	<0.020	<0.200	<0.730	<0.019	<0,019	<0,019	<0.017	R	R
Endrin ketano					<0.040	<0.004	<0.004	<0.040	<0.140	<0.0036	<0.0036	< 0.0036	< 0.0033	<0.0033	<0.004
Toxaphene					<0.400	<0.040	<0.040	<0.400	<1,400	<0.036	<0.036	<0.036	< 0.033	ิส	R

Tozaptene Tozaptene Notes: MCP 5-2/3GW-3 Standards Klentified as cleanup goals in Action Merrorandum • standard is for mixed isomers

J = estimated

R = rejected

< = kess than

Tr CONFIRMATORY AOC 57 AREA 3 REMOVAL ACTION AOC 57 AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	MCP	MCP	RISK	RISK	ED57W10X	EXS7W11X	EX57W12X	EX57W13X	EX57W14X	EX57W15X	ED57W15X	EX57W16X	EX57W17X	EX57F01X	EX57F02X	EX57F03X
DATE COLLECTED	S-1/GW-1	S-ZIGW-3	BASED	BASED	3 ft bgs 16-Apr-99	4. ft bge 16-Apr-89	1 ft bge 15.Apr-89	2 Tt bgs 16-Apr-99	2 11 bgs 11 Jun-99	1 11 bgs	1 11 bgs	2 11 Jun-99	2 ft bgs 11-Jun-99	6 П. Dgs 25-Mar-99	4 11 Dg5 25-Mar-99	5 Apr-99
	(B/8H)	(3/Brt)	(5,61)	(6,6rl)												
VPH (pg/g)		000				UNC		A REAL PROPERTY	416	20	602	-14D	245	<18 <18	<18	<15
n-C5 to n-C8 Aliphatic	100	1005				2500	38	4.2	25	30	3.5	870	; ¥	1	9.2	; 4
n-C9 to n-C10 Aromatic	100	200			4	1900	55	44	55	3	<5.4J	600	C1,⊳	5.2	6.5	5
Benzene	10	8			8	240	. 27	73	212 7	<140	<1601	<1000 v	1015	86	53	6, 7 7
Ethyberzene m.o.Yvene		100			52	389	7 ¥	13	6.75			<72	47.5	9	1.€ 1.5	474
MTBE	0.3	200			6,5	246	CA CA	46N	6.2	<7.5	<8.2	₹	£.6	\$7.0	€.8	£.6
Naphthatene	-	1000		~~ ~~	\$	200	53	77	230 230	300	3101	<2100	2101	9 7 7	9.15 9.15	55
o-Xylene Tokooo	005	1000			5 5	8 9 1	00 00	4 4 5 3		<290	310L	2100	210	0.2	6.8	99 99
FPH (Inda)	*						Contraction of the	STATE ALSO								
n-C9 to n-C18 Aliphatic	1000	2500	NA	NA	0.15	0061	2101	19	920	880	650	1300	9°€>	84	<7.5	<7.5
n-C19 to n-C36 Alphatic	2500	5000	20000	20000	0'12	10000	6002	1500	20000	2011	6700	2600	8.12 1	065	5	₹75 50
IFC11 to n-C22 Animatic	200	2000	2000	10000	÷.	23002	830	<u>8</u> ;	3100	1300	1100			110	8	₽ f
2-Methymaphthalene	4	1000				E.	2	25	ġ ų	2.0			015 218	200		
Acenaphihene	202	7007				75) (1.0	79	18		2	8.15	200	6.15	5
Activation		2500				8 8	23	AH A	\$9×	22	23	€.\$	<1.8	20	<1.9	<1.9
Alkin auctor Renzefalardhranne	0.7				4.8	3.8	24	211	<6.4	22	23	3.9	<1.8	\$2.0	<1.9	c.1>
Benzolalowene	0.7	0.7			<1.8	8.6 8	2.4	-21	<5.4	<22	23	٩. ٩	<1.8	<2.0	<1.9	6.1 3
Benzolbitkoranthere	0.7				<1.8	3.5	34	21	<6.4	22	23	00	51.8	2.0	€¦₽	¢.15
Benzold,h.liperyene	1000	2500			<1.8	8.E>	24	<u>Å</u> 2	<5.4	<2.2	23	00	<1.8	20	419	¢.15
Benzo(k) fiboranthene	7	8			<1.8	38	E	22	<6.4	22	3	٢ ۲	8.12 8.12	2.0	¢.15	¢. ₽
Chrysene	7	9			≤1.8	100 N	44	211	₽.9	22	8	V.	8	20 20	5.12 5.12	¢ V
Dibenzo(a,h)anthracene	0.7	0.7			18	5	5	68	6.4 2	22	₹ } {	₩ 0 0	v, 1	8 8 8	0, 1 1	5
Fluoranthene	1000	009			5 1 V 1	₹ .	1	3	4.9	36	3 5	7 7		20	5 V	7 7
Fluorene	400	000				Ĵ.	\$ č		494 494	10	3 8	÷₹	77	78	e 15	0 1 1 1
indeno(1,2,3-cu)pyrene		1000			1	} P	12	F₹	64	12	5	4	. £	2.0	1.9.	e,1>
Naµoniastera: Phenoidherne	200	100			51.8	5.6	44	2,1J	<6.4	22	8	\$	€.1.8 1.1.8	20	€,1:9	€'1-9
Pyrene	200	2000			<1.8	3.8	24	32.1)	<6.4	<2.2	23	2.5	4 <u>1</u> 8	<2.0	<1.9	c1.5
PCBs (µg/g)						SAME AND ADDRESS		an itse sources								1 200
PCB-1016	3	2	2	4	<0.020	\$0200	-0.540	09100	<0.240	<0.025	<0,026	40.022	<0.020	<0.024	CC0.0	<0.020
PCB-1221	<u> </u>	~	21.0	4.	0000	8 8 8 9 9	21.00	028.0	<0.470	<0,049	20.02	240'0×		<0.045	C40.02	
PCB-1232		NF	7 6	4 4		Ne.	01540		CD 240	<0.025	40.026	<0.022	<0.020	<0.024	40.022	<0.020
PUB-1242 DCD-1248		10	• ~	1 74	<0.020	40,200	40.540	4	<0.240	<0.025	<0.026	<0,022	<0.020	<0.024	<0.022	<0.020
PCB-1254		N	0	4	<0.020	-0200	-0.540		<0.240	<0,025	<0.026	<0.022	<0.020	<0.024	<0.022	<0.020
PCB-1260	~	2	2	4	<0.020	80.418.02 3.5	11	3.6	4.3	<0.025	<0.026	<u>40.022</u>	<0.020	2.6	<0.022	0.056
PESTICIDES (µg/g)																
aipha-BHC					<0.002	60 (CS)	40054	0000	<0.024	<0.026	<0.026	40,022	6.020	<0.024	40.0022	000
gamma-BHC (Lindare)					<0.002	40.020	NO.S		40,UZ4	670.0×	920 U-4			×0.024		
Heptachtor	1.0	70 2				35		20 C	<0.024	<0.026	40.026	<0.022	<0.020	<0.024	<0.0022	×0.002
	fn:n	5			20.02.1	1020 A	A DEAL	COMBI	<0.024	<0.026	<0.026	<0.022	€0.020	<0.024	<0.0022	<0.002
					<0.002	020.02	100.02	-0.04B	<0.024	<0.026	<0.026	<0.022	<0.020	<0.024	<0.0022	<0.002
vexaterru. Mentachlor enoxide	0.06	0.09			<0.002J	-0201	ch80.05	-0.0483	<0.024	<0.026	<0.026	220'0>	<0.020	<0.024	<0.0022	<0,002.1
Endosuitan 1	29	0.05			<0.062J	\$0,020U	-0.06U	40.04BJ	<0.024	<0.025	<0.026	<0.022	<0,020	<0.024	<0.0022	<0.002
gamma-Chloidane		2			<0.002J	40.0201	17900	-00481	<0.024	<0.026	<0.026	<u>6.02</u>	<0.020	<0.024	<0.0022	<0.002
alpha-Chlordane		2			<0.002J	-0-2070	1900	SOCABI	<0.024	<0.026	40.025	\$0.022	020.05	<0.024	200,022	-002 C
4,4*005	2	2			A0.024		0.12		2101.045					50,040		
Dieldrin	0.0	0.04				3			1.0			20.0				1000
Endras	<u>,</u>							1 COLUM	<0.005	22.0	72.0	020	0000	0.74	C100.0>	<0.004
4,4**UUU	•	2				Cord of	210	12000	<0.046	<0.050	40.050	43	0100	\$0.046	<0.0043	<0.04
stroususait II A A-MAT	~	~			<0.004	A DRD	111	0.022	<0.046	<0.050	<0,050 <0.050	CH0.043	<0.040	0.04G	<0.0043	<0.04
Fordia a Mehuda					<0.004	0000	0110		<0.046	<0.050	<0:020	<0.043	<0.040	0.046	<0,0043	<0.04
Endosultan suitate					<0.004.0	20.040J		<0.062J	<0.046	<0.050	050,050	<0.043	<0.040	<0.046	<0.0043	<0.0040
Methoxychior	ŝ	30			œ	۲	R	8	<0.240	<0.260	<0.260	Q220	<0.200	40°54	-0.02 220	œ
Endrin ketane					40.0¢	90 90 90	91 . 9	280,082	<0.046	<0.050	020,050	0.043	0000		<0.0043	-0000
Toxaphene					¥	N States	N. South of the State	Number of the second second	<0.450	Mc/No		 <td>20.4 IO</td><td>1. 40</td><td>540-D2</td><td>2</td>	20.4 IO	1. 40	540-D2	2
Notas: NCD 5 200181-2 Street and March	ouncelo ac bo	ooale in Acti	verometri oo	und												
* = standard is for mixed isomers	ria es nacemb															
J ≂ estimated																
R a rejected																
< = less than	ł															
	🚽 = sample lo	ications remo	wed during st	ibsequent excava	_											

2 of 2

TABLE 9-1 SOIL SAMPLES USED IN HHRA AOC 57

MEDIA	AREA	SAMPLE LOCATION	DEPTH (Ft bgs)	ANALYSES		
Surface Soil	Area 2 - Industrial	57B-95-01X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57B-95-02X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57E-95-02X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57E-95-10X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57E-95-25X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
	Area 2 - Recreational	57E-95-12X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57E-95-16X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57E-95-17X	0 -2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
		57S-98-01F	1 - 2	трн, vpн, ерн		
		57S-98-01X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-02F	0 - I	ТРН, VPH, ЕРН		
		57S-98-02X	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-04F	1 - 2	ТРН, VPH, ЕРН		
		57S-98-04X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-06F	1 - 2	трн, vpн, ерн		
		57S-98-06X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-07F and Dup	0 - 1	ТРН, VPH, ЕРН		
		57S-98-07X and Dup	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-07F	1 - 2	ТРН, VPH, ЕРН		
		57S-98-07X	l - 2	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-08F	0 - 1	TPH, VPH, EPH		
		57S-98-08X	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-09F	0 - 1	ТРН, VPH, ЕРН		
		57S-98-09X	0 - 1	Inorganics, Pest/PCBs, SVOCs, VOCs		
	Area 3 - Industrial	57B-96-08X	0 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
			EX57W05X	3	Pest/PCBs, VPH, EPH	
	1	EX57W10X and Dup	3	Pest/PCBs, VPH, EPH		
		EX57W02X and Dup	3	Pest/PCBs, VPH, EPH		
		EX57W17X	2	Pest/PCBs, VPH, EPH		
		57B-96-09X	0 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH		
	Area 3 - Recreational	57S-98-13F	1 - 2	ТРН, VPH, ЕРН		
		57S-98-14F	1 - 2	трн, vpн, ерн		
		57S-98-13X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs		
		57S-98-14X	1 - 2	Inorganics, Pest/PCBs, SVOCs, VOCs		
		EX57F03X	3	Pest/PCBs, VPH, EPH		
		EX57W14X	2	Pest/PCBs, VPH, EPH		
		EX57W15X	1	Pest/PCBs, VPH, EPH		
		EX57W16X	2	Pest/PCBs, VPH, EPH		

TABLE 9-1 SOIL SAMPLES USED IN HHRA AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

MEDIA	AREA	SAMPLE LOCATION	DEPTH (Ft bgs)	ANALYSES
Subsurface Soil	Area 2 - Industrial	57B-95-01X	5-7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-01X	6 - 8	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
	· · · · · · · · · · · · · · · · · · ·	57B-95-02X	5-7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-04X and Dup	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
	Area 2 - Recreational	57E-95-07X	4 - 6	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-08X	4 - 6	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-09X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-13X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-14X	6 - 8	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-15X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-16X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-18X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-19X	2 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-20X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57S-98-03F	2 - 3	ТРН, VPH, ЕРН
		57S-98-03X	2 - 3	Inorganics, Pest/PCBs, SVOCs, VOCs
· · · · · · · · · · · · · · · · · · ·		57S-98-05F	3 - 4	ТРН, VPH, ЕРН
		57S-98-05X	3 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs
	Area 3 - Recreational	57S-98-15F	3 - 4	трн, урн, ерн
		57S-98-15X	3 - 4	Inorganics, Pest/PCBs, SVOCs, VOCs
:	Area 3 - Industrial	57B-96-08X	5-7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57B-96-09X	5 - 7	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57E-95-01X	6 - 8	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		57B-96-11X and Dup	10 - 12	Inorganics, Pest/PCBs, SVOCs, VOCs, TPH
		EX57W06X	5	Pest/PCBs, VPH, EPH
		EX57W07X	5	Pest/PCBs, VPH, EPH
		EX57W08X	5	Pest/PCBs, VPH, EPH
		EX57W09X	4	Pest/PCBs, VPH, EPH
	· · · · · · · · · · · · · · · · · · ·	EX57F01X	6	Pest/PCBs, VPH, EPH
		EX57F02X	8	Pest/PCBs, VPH, EPH

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TABLE 9-2 EXCAVATED SOIL SAMPLES AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

MEDIA	AREA	SAMPLE LOCATION
Soil	Area 3 - Recreational	57B-96-12X
	Area 3 - Industrial	EX57W01X
		EX57W03X
		57B-96-07X
		57R-96-14X
		57R-95-04X
		57R-95-06X
		57E-96-30X
		57E-96-31X
		57R-95-03X
		57R-96-18X
		57B-96-10X
		57E-96-28X
		57R-96-12X
		57R-96-19X
		57E-95-24X
		57B-98-11X
		57E-96-29X
		57R-95-02X
		57R-96-13X
		57R-96-15X
		57R-96-16X
		EX57W01X
		EX57W03X
		EX57W04X
		EX57W11X
		EX57W12X
		EX57W13X

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TABLÉ 9-3 GROUNDWATER SAMPLES USED IN HHRA AOC 57

MEDIA	AREA	SAMPLE LOCATION	SAMPLE #	DATE	U/F	ANALYSES
Groundwater	Area 2 - Upgradient	57M-95-01X	DV4F168	2/13/96	F	Inorganics
		57M-95-01X	DV4W168	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-01X Dup	DV4F455	2/13/96	F	Inorganics
		57M-95-01X Dup	DV4W455	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-02X	DV4F170	2/13/96	F	Inorganics
		57M-95-02X	DV4W170	2/13/96	υ	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-98-02X		5/26/98		TPH, VPH, EPH
		G3M-92-02X	DV4F164	2/12/96	F	Inorganics
	Area 2 - Industrial	57M-95-05X	DV4F176	2/13/96	F	Inorganics
		57M-95-05X	DV4W176	2/13/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-06X	DV4F178	2/15/96	F	Inorganics
		57M-95-06X	DV4W178	2/15/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
	Area 2 - Recreational	57M-95-04A	DV4F174	2/14/96	F	Inorganics
		57M-95-04A	DV4W174	2/14/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-04B	DV4F459	2/14/96	F	Inorganics
		57M-95-04B	DV4W459	2/14/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-98-04X		5/27/98		ТРН, VPH, ЕРН
		57M-98-04X - Dup		5/27/98		ТРН
		57M-95-07X	DV4F180	2/14/96	F	Inorganics
		57M-95-07X	DV4W180	2/14/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-08A	DV4F182	2/15/96	<u> </u>	Inorganics
		57M-95-08A	DV4W182	2/15/96	UU	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-08B	DV4F462	2/15/96	F F	Inorganics
		57M-95-08B	DV4W462	2/15/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57P-98-02X	ADV1W20	5/26/98		Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57P-98-02X	ADV1W21	5/26/98	F	Inorganics
	Area 3 - Industrial	57M-95-03X	DV4F172	2/14/96	F	
		57M-95-03X	DV4W537	10/2/96	<u> </u>	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
		57M-95-03X - Dup	DV4F458	2/14/96	ŀ	
······································		57M-98-03X		5/26/98	· · · · · · · · · · · · · · · · · · ·	
		57M-96-09X	DV4W533	10/1/96	<u> </u>	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
	Area 3 - Recreational	57M-96-10X	DV4W534	10/2/96	U	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem, TPH
	· · · <u>· · · · · · · · · · · · · · · · </u>	<u>57M-96-11X</u>	ADV1W26	5/2//98	<u> </u>	Inorganics, Pest/PCBs, SVUCs, VUCs, Wet Chem
		57M-96-11X	ADV1W27	5/27/98	<u> </u>	Inorganics
		57M-96-11X - Dup	ADV1W28	5/2//98	<u> </u>	Inorganics, Pesi/PCBs, SVOUs, VOUs, Wei Chem
		57M-96-11X - Dup	ADV1W29	5/2//98	F	
		5/M-98-11X		5/27/98	.[
		0/M-98-11X - Dup		10/0/00	11	IFR, VER, CER
		5/M-96-12X	DV4W306	10/2/96		Inorganics, resvinues, avous, vous, weitunem, IPH
		5/M-96-13X	DV4VV307	10/2/90		Inorganico, Fest/FCDs, SVOCs, VOCs, Wet Chem, IPH
		57P-98-03X	ADV1W22	5/20/98	<u> </u>	Inorganics, Pest/PCBs, SVOCs, VOCs, Wet Chem
		57P-98-03X	ADV1W23	5/20/98		
		57P-98-04X		5/20/98	<u> <u>P</u></u>	Inorganics, Pest/PCBs, SVUUs, VUUs, Wet Chem
	1	5/P-98-04X	ADV1W25	0/20/98		inorganics



TABLE 9-4 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 INDUSTRIAL USE SURFACE SOIL

	Range	requency		Concentrati	ion 🕖 👘				9023529	
	of	of	Maximum	Arithmetic	95%	Back-	Region III	a solution of		
	SQLs	Detection	Detected	Меап	UCL	ground*	RBC**	ARARs	CPC?	Notes
SURFACE SOIL (0 - 2 feet b)	gs) (mg/kg)*									
DAT METALC										
Aluminum		5/5	7530	6700	NC	18000	7800	NA	No	Less than RBC 2 Background
Ammun	e and see the state warray and state more the	J / J	010	145	NC NON	10000	0000 0 43	NA	Vec	Proceeds RBC
Alsellic		5/5	40.0	76 3	NC	54	550	NA	No	Less than RBC ² Background
Darium	0.50 0.50	1/5	0 705	0.341		0.81	16	NA	No	Less than RBC 2 Background
Coloium	0.30 - 0.30	5/5	880	407	NC	810	NA	NA	No	* Essential Netrient
Clarin		515		150	NC	33	111	NIA	Ver	Byceeds RR() ² Background
Catal		E / E	7 57	A 64	NC	47	470	NA	hio	Less than RBC
Cooalt		515	1.55	4.04	NC	12.5	310	NA	No	Less than RBC
Copper			12.0	11	NC	13.5	010	11A	INU Marine Marine br>Marine Marine Ma	* Evcende: 8 BC2 Backerround
iron	and the second second	<u></u>	10400	14		10000	2300	4005	Neo Long	¹ Lass than ADAD ² Dackground
Lead			22.9	14	NC	40			NO No	Eccential Nutriant - Dackground
Magnesium	and a standard standard standard standard	3/3	4020	2370	NL	3300	NA 1 CO	INA	INO	Essential Nutrien, Dackground
Manganese	AND ADDRESS OF GRADINESS	5 / S	481	282	NU	380	LOU	iva -	Yes	Li ana dhan DDC
Nickel		5/5	30.7	16.8	NC	14.6	160	NA	No	Less man RBC
Potassium		5/5	1170	654	NC	2400	NA	NA	NO	Background, Essential Nutrient
Selenium	0.25 - 0.25	1/5	0.883	0.277	NC	ND	39	NA	No	Less than RBC
Sodium		5/5	436	327	NC	131	NA	NA	No	Essential Nutrient
Vanadium		5/5	15.5	12	NC	32.3	55	NA	No	Less than RBC, * Background
Zinc		5/5	38.1	24.2	NC	43.9	2300	NA	No	Less than RBC, Background
DESTICIDES/DCR.										· · · · · · · · · · · · · · · · · · ·
A ADDE	0.0077 - 0.0077	1/5	0.0199	0.007	NC		19	NA	No	Less than RBC
4,4-008	0.0071 0.0071	1/5	0.0155	0.007	NC	 	1,5	NA	No	Less than RBC
+,4-DD1	0.0071-0.0071	175	0.0237	0.000				1.41		
PAL SEMIVOLATILE ORG	ANICS									
2-methylnaphthalene	0.049 - 0.2	2/5	0.43	0.201	NC		160	NA	No	' Less than RBC
Bis(2-ethylhexyl) Phthalate	0.62 - 3	2 / 5	2.7	1.6	NC	-	46	NA	No	Less than RBC
Dibenzofuran	0.035 - 0.2	1/5	0.16	0.0825	NC	-	31	NA	No	Less than RBC
Fluoranthene	0.3 - 0.3	3/5	0.3	0.161	NC	_	310	NA	No	' Less than RBC
Nanhthalene	0.037 - 0.2	3/5	0.42	0.208	NC		160	NA	No	' Less than RBC
Phenantlurene	0.2 - 0.2	4/5	0.28	0.145	NC		230*	NA	No	Less than RBC
Pyrene	0.2 - 0.2	4 / 5	0.4	0.181	NC		230	NA	No	' Less than RBC
PAL VOLATILE ORGANIC	:\$									
Chloroform	0.00087 - 0.00087	ι/5	0.00089	0.00053	NC	_	100	NA	No	Less than RBC
Ethylbenzene	0.0017 - 0.0017	1/5	0.0024	0.0012	NC		780	NA	No	Less than RBC
Tetrachloroethylene	0.00081 - 0.00081	1/5	0.003	0.00092	NC	_	12	NA	No	Less than RBC
Toluene	0.00078 - 0.00078	3/5	0.0037	0.0017	NC		1600	NA	No	Less than RBC
Trichlorofluoromethane	0.0059 - 0.0059	3 / 5	0.017	0.0075	NC		2300	NA	No	Less than RBC
Xylenes	0.0015 - 0.0015	1/5	0.029	0.0064	NC		16000	NA	No	Less than RBC



TABLE 9-4 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 INDUSTRIAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS



NOTES:

Based on samples from 57B-95-01X, 57B-95-02X, 57E-95-02X, 57E-95-10X, 57E-95-25X
 USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)
 Value for pyrene used as surrogate
 For calculation of the CPC for TPH see Table@.
 Background: Maximum concentration in Fort Devens background listed;

See Appendix F for development of background

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for surface soil evaluation. RBCs based on carcinogenic effects are associated with a 1x10"cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

* Less than RBC - Maximum detected concentration is less than risk-based concentration

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

* Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration mg - milligram kg - kilogram bgs - below ground surface SQL - Sample Quantitation Limit NA - No value available ND - Not detected NC - Not calculated because there are lewer than 10 samples. - Not applicable PAL - project analyte list UCL - upper confidence limit ARARs - Applicable or Relevant and Appropriate Requirements CPC - Contaminate of concern DDE - dichlorodiphenyldichloroethylene DDT - dichlorodiphenyltrichlorothylene

TABLE 9-5 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

 Frequency
 Concentration

 of
 Maximum
 Arithmetic
 95%
 Back Region III

 Detection
 Detected
 Mean
 UCL
 ground*
 RBC**
 ARARs
 CPC?

SURFACE SOIL (0 - 2 feet bgs) (mg/kg)*

Range

SQLs

	/(8/8/									······································
	······									
PAL METALS				······································						
Aluminum		3/3	6180	4930	NC	18000	7800	NA	No	¹ Less than RBC, ² Background
Antimony	1.09 - 7.14	1 / 11	1.62	2.84	5.87	0.5	3.1	NA	No	' Less than RBC
Arsenic		11 / 11	61.2	24.1	47.9	19	0,43	NA .	Yes	^a Exceeds RBC
Barium		11 / 11	113	47.9	106	54	550	NA	No	'Less than RBC,
Beryllium	0.50 - 0.50	1/3	0.708	0.403	NC	0.81	16	NA	No	Less than RBC, 2 Background
Calcium		3/3	528	399	NC	810	NA	NA	No	² Background, ⁴ Essential Nutrient
Chromium		3/3	15.4	12.7	NC	33	23	NA	No	¹ Less than RBC, ² Background
Cobalt		3/3	2.31	2.11	NC	4.7	470	NA	No	Less than RBC, 2 Background
Copper		11 / 11	41.3	15.6	39.3	13.5	310	NA	No	Less than RBC
Iron		3 / 3	7920	6830	NC).	18000	2300	NA	Yes	³ Exceeds RBC, ³ Background
Lead		11 / 11	320	143	459	48	NA	400 •	No	² Less than ARARs
Magnesium		3/3	1390	1220	NC	5500	NA	NA	No	² Background, ⁴ Essential Nutrient
Manganese Managanese with		-11 / 11	679	149	273	380	160	NA	Yes	³ Exceeds RBC
Nickel		3/3	10.4	7.95	NC	14.6	160	NA	No	¹ Less than RBC, ² Background
Potassium		3/3	460	377	NC	2400	NA	NA	No	* Background, * Essential Nutrient
Sclenium	0.25 - 2.42	7 / 11	27.9	7.84	437	ND	39	NA	No	' Less than RBC
Sodíum		3/3	446	362	NC	131	NA	NA	No	*Essential Nutrient
Vanadium		3/3	14	10.7	NC	32.3	55	NA	No	Less than RBC, 2 Background
Zinc	8.03 - 8.03	10 / 11	150	55.1	183	43.9	2300	NA	No	' Less than RBC, 2 Background
			· · · · · · · · · · · · · · · · · · ·							
PESTICIDES/PCBs										
4,4'-DDD	0.0083 - 0.0083	1 / 11	0.0372	0.0071	0.0104		2.7	NA	No	Less than RBC
4,4'- DDE	0.0077 - 0.0077	4 / 11	0.0524	0.0131	0.034		1.9	NA	No	'Less than RBC
4,4'-DDT	0.0071 - 0.0071	4 / 11	0.18	0.0388	0.427		1.9	NA	No	Less than RBC
Dieldrin	0.0063 - 0.0063	4 / 11	0.032	0.0099	0.0245		0.04	NA	No	Less than RBC
Aroclor-1260	0.0804 - 0.0804	8 / 11	4.2	0,625	3.6	and the 🛥 reg	0.32	NA	Yes	*Exceeds RBC
PAL SEMIVOLATILE ORGA	NICS								_	
2-Methylnaphthalene	0.049 - 0.5	1 / 11	0.6	0.176	0.383		160	NA	No	' Less than RBC
Acenapthylene	0.033 - 0.3	1 / 11	0.4	0.13	0.259		160°	NA	No	Less than RBC
Benzo(k)fluoranthene	0.066 - 0.7	1 / 11	1	0.266	0.601		8.7	NA	No	' Less than RBC
Chrysene	0.12 - 1	1 / 11	I	0.386	0.712		87	NA	No	1 Less than RBC
Fluoranthene	0.068 - 0.7	3 / 11	2	0.584	2.75		310	NA	No	Less than RBC
Naphthalene	0.037 - 0.4	1 / 11	0.4	0.143	0.301		160	NA	No	Less than RBC
Phenanthrene	0.033 - 0.3	5 / 11	1	0.389	2.32		160°	NA	No	'Less than RBC
Pyrene	0.033 - 0.3	5 / 11	2	0.625	6.62		230	NA	No	' Less than RBC
Di-n-butyl Phthalate	0.061 - 0.6	1 / 11	2.0	0.329	0.771		780	NA	No	'Less than RBC

Notes

TABLE 9-5 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Range	Frequency		Concentration	a 👘 👘		le a la serie				1.		
	of	of	Maximum	Arithmetic	95%	Back-	Region III	Section 201				-	
	SQLs	Detection	Detected	Mean	UCL	ground*	RBC**	ARARs	CPC?		Notes		1.1
PAL VOLATILE ORGANICS													
1,2-Dichloroethylenes (Total)	0.003 - 0.003	2 / 11	0.016	0.0036	0.0069	-	70	NA	No	Less than RBC			
Acetone	0.017 - 0.017	2 / 11	0.33	0.029	0.0672	_	780	NA	No	Less than RBC			
Methylene Chloride	0.012 - 0.012	1 / 11	0.015	0.0068	0.0081	-	85	NA	No	' Less than RBC		· · · · · ·	
Ethylbenzene	0.0017 - 0.0017	2 / 11	0.022	0.003	0.0059	-	780	NA	No	'Less than RBC			
Tetrachloroethylene	0.00081 - 0.00081	2 / 11	0.0047	0.0009	0.0014		12	NA	No	'Less than RBC			
Toluene	0.00078 - 0.00078	2 / 11	0.0083	0.0017	0.0051	_	1600	NA	No	¹ Less than RBC			
Trichlorofluoromethane	0.0059 - 0.0059	3 / 11	0.014	0.0048	0.0072		2300	NA	No	' Less than RBC			
						·							
OTHER													
Total Petroleum Hydrocarbons		11 / 11	17,000	3500	NC [*]	and the second s	NA	NA NA	Yes	Vo standard availab	lc		
VPH Ranges											The Westman Company of Company of Company	and the second design of the second	and the former that I give have a
C9-C12 Aliphatics		7 / 8	15	6.1	NC		NA	NA	Yes	No standard availab	le	1994 B. 1997	
C9-C10 Aromatics ⁴		2/8	16.5	4.6	NC		NA	NA	Yes	No standard availab	le		
EPH Ranges											-		
C9-C18 Aliphatics		2/8	. 270	79	NC		NA	NA	Yes	/No standard availab	le		a state and the
C19-C36 Aliphatics		7 / 8	1,950	670	NC		 NA 	NA	Yes	No standard availab	le	1. St. 19	a de la seconda
C11-C22 Aromatics	- 11- 11- 11- 11- 11- 11- 11- 11- 11- 1	6 / 8	550	247	NC		NA	NA	Yes	No standard availab	le		1997 - S. 1 1997 - S. 1997 - S. 19 1997 - S. 1997 - S. 19
		<u> </u>											
NOTES:													

"Based on samples from 57E-95-12X, 57E-95-16X, 57E-95-17X, 57S-98-01X (1 ft), 57S-98-02X, 57S-98-04X (1 ft), 57S-98-06X (1 ft),

57S-98-07X and its duplicate, 57S-98-07X (1 ft), 57S-98-08X, 57S-98-09X

"USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

* Value for naphthalene used as surrogate.

* For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

* Exposures to petroleum are evaluated using EPH/VPH data. See appendix @.

*Background: Maximum concentration in Fort Devens background listed;

See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for surface soil evaluation

RBCs based on carcinogenic effects are associated with a 1x10" cancer risk level;

RBCs based on noncarcinogenic effects are associated with an adjusted HQ of 0.1 (USEPA, 1999).

Less than RBC - Maximum detected concentration less than risk-based concentration

* Background - Sample concentrations detected are at or below background concentrations.

' Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, polassium, sodium) and is not considered a CPC.

2 Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

" Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration mg - milligrams kg - kilograms ARARs - Applicable or Relevant and Appropriate Requirements bgs - below ground surface SQL - Sample Quantitation Limit NA - No value available - Not applicable NC - Not calculated because there are fewer than 10 samples. PAL - project analyte list UCL - upper confidence limit CPC - Contaminant of concern DDD - dichlorodiphenyldichloroethane DDE - dichlorodighenyldichloroethene DDT - dichlorodiphenyltrichloroethane

TABLE 9-6 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 INDUSTRIAL USE SURFACE SOIL

	Range	Frequency		Concenti	ration		1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -			
Second and the first second	of FOU-	of	Maximum	Arithmetic	95%	Back-	Region III	ARAR	CPC2	Notes
	ું ગુપાડ	Detection	Detected	Titean			- ADC	ANAIG		rivio.
SUPEACE SOIL (0 - 2 feet bg	e) (mg/kg) ¹									
SURFACE SOLD (0 = 2 leet bg.	s) (mg/kg)		· · · ·					· · ·		
PAL METALS	· · · · · · · · · · · · · · · ·						••••••••••••••••••••••••••••••••••••••			
Aluminum		2 /	2 710	0 6735	NC	18000	7800	NA	No	¹ Less than RBC, ² Background
Arsenic		2 /	2 4	1 23.1	NC	19	0.43	NA	Yes	'Exceeds RBC
Barium		2 /	2 29.3	20.2	NC	54	550	NA	No	'Less than RBC, 'Background
Cadmium	0.7 - 0.7	1 /	2 1.5	0.925	NC	1.28	3.9	NA	No	' Less than RBC
Calcium	100 - 100	I /	2 283	167	NC	810	NA	NA	No	² Background, ⁴ Essential Nutrient
Chromium		2 /	2 11.7	11.2	NC	33	23	NA	No	Less than RBC, 2 Background
Cobalt		2 /	2 3.23	2.8	NC	4.7	470	NA	No	' Less than RBC, ' Background
Соррст		2 /	2 6.83	6.06	NC	13.5	310	NA	No	'Less than RBC, ' Background
Iron		21	2 804	0 7740.	NC	18000	2300	NA	Yes	*Exceeds RBC, *Background
Lead		2 /	2 32.7	20.3	NC	48	NA	400	No	⁴ Less than ARARs
Magnesium		2 /	2 165	0 1600	NC	5500	NA	NA	No	² Background, ⁴ Essential Nutrient
Manganese		2 /	.2 54	8 318	NC	380	160	NA ·	Yes	¹ Exceeds RBC
Nickel		2 /	2 11.	1 10.8	NC	14.6	160	NA	No	' Less than RBC, ' Background
Potassium		2 /	2 68	3 446	NC	2400	NA	NA	No	² Background, ⁴ Essential Nutrient
Sodium		2 /	2 43	5 418	NC	131	NA	NA	No	*Essential Nutrient
Vanadium		2 /	2 9.41	9.29	NC	32.3	55	NA	No	' Less than RBC, ' Background
Zinc		2 /	2 28.5	22.6	NC	43.9	2300	NA	No	Less than RBC, ' Background
PESTICIDES/PCBs										
4,4'- DDE	0.0004 - 0.04	17	6 0.008	1 0.006	NC	-	1.9	NA	No	' Less than RBC
4,4'-DDT	0.0004 - 0.04	17	6 0.0121	0.0066	NC		1.9	NA	No	Less than RBC
PAL SEMIVOLATILE ORGA	ANICS									
Fluoranthene	0.068 - 1.8	1 /	6 0.14	0.61	NC		310	NA	No	Less than RBC
Naphthalene	0.037 - 230	1 /	10 0.04	8 12.5	NC		160	NA	No	Less than RBC
Phenanthrene	0.033 - 1.8	1 /	6 0.1	1 0.604	NC		160 •	NA	No	' Less than RBC
Рутепе	0.033 - 1.8	1 /	6 0.1	5 0.61	NC		230	NA	No	Less than RBC
PAL VOLATILE ORGANICS	3									
Toluene	5.9 - 230	2 /	6 0.003	0.0017	NC	-	1600	NA	No	Less than RBC
OTHER										
Total Petroleum Hydrocarbons*		2- 1	2 50) 44.5	NC		NA	NA .	Yes	No standard available
VPH Ranges										
C9-C12 Aliphatics	3.8-5.4	$\sim 1 J$	4 - 16	5.74	NC		NA	NA	🔍 Yes	'No standard available
C9-C10 Aromatics	3.8-4.7	1 7	4 4.85	2.78	NC		NA	NA	Yes	No standard available

TABLE 9-6 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 INDUSTRIAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Range Frequency Concentration Region III Maximum Arithmetic 95% Backof of RBC** ARARs --- CPC? Notes Detected Mean UCL ground* SQLs Detection EPH Ranges C19-C36 Aliphatics 4.8, 7.0 1 / 4 7.28 4.09 NC - NA NA Yes -⁷ No standard available

NOTES:

* Based on samples from 57B-96-08X, 57B-96-09X, EX57W02X and Dup, EX57W10X and Dup, EX57W05X, and EX57W17X

* USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

* Value for naphthalene used as surrogate.

* For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

*Background: Maximum concentration in Fort Devens background listed;

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation RBCs based on carcinogenic effects are associated with a 1x10" cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

1 Less than RBC - Maximum detected concentration is less than risk-based concentration.

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

" Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

"Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based Concentration mg - milligram kg - kilogram -- Not applicable ARARs - Applicable or Relevant and Appropriate Requirements SQL - Sample Quantitation Limit NA - No value available ND - Not detected NC - Not calculated PAL = project analyte list UCL - upper confidence limit CPC - contaminant of concern

TABLE 9-7 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SURFACE SOIL

	Range	Frequenc	y .		Concentr	ation					
 Contraction of the second se Second second seco	of	of		Maximum	Arithmetic	95%	Back-	Region III	ADAR-	000	The state of the second second second second second
- Las de Provinsi de la composición de las de	ડિઇટાર	Detection	n de Se	Detected	mean	- UUU	RIOTHO.			CLO:	TIOICS
SUBELOE COLL (A. 2 S	has (maile) 2								· · · · · · · · · · · · · · · · · · ·		
SUKRACE SULL (0 - 2 1661	nga) (mg/kg)				<u> </u>						
PAL METALS	·										
Arsenic		2 /	2	28	26.8	NC	19	0,43	NA	Yes	'Exceeds RBC
Barium		2 /	2	17.1	15.9	NC	54	550	NA	No	¹ Less than RBC, ² Background
Соррег		2 /	2	3.46	3.2	NC	13.5	310	NA	No	¹ Less than RBC, ² Background
Lead	10.5 - 10.5	1 /	2	22	13.6	NC	48	NA	400 •	No	³ Less than ARAR, ² Background
Manganese		2 /	2	-170	120	NC	380	160	NA	Yes	³ Exceeds RBC, ² Background
Selenium		2 /	2	8.29	8.21	NC	ND	39	NA	No	¹ Less than RBC
Zinc		2 /	2	27.5	21.7	NC	43.9	2300	NA	No	Less than RBC, ' Background
PESTICIDES/PCBs											
4,4'- DDD	0.004 - 0.046	3 /	6	0.29	0.102	NC		2.7	NA	No	Less than RBC
4,4'-DDT	0.004 - 0.05	1 /	6	0.0248	0.0166	NC		1.9	NA	No	Less than RBC
Chlordane - Alpha	0.0013 - 0.0013	1/	2	0.0028	0.0017	NC		1.8 '	NA	No	Less than RBC
Chlordane - Gamma	0.0013 - 0.0013	1 /	2	0.0028	0.0017	NC		1.8 *	NA	No	· Less than RBC
Dieldrin	0.004 - 0.05	··· 2 /··	6		0.0432	NC		0.04	NA NA	Yes	Exceeds RBC
Endrin	0.004 - 0.05	2 /	6	0.07	0.0263	NC		2.3	NA	No	· Less than RBC
Aroclor 1260	0.022 - 0.0804	3 /	6	4.3	0.816	NC		0.32	NA	No	· Less than RBC
PAL SEMIVOLATILE OI	RGANICS										11
1,2-Dichlorobenzene	0.11 - 0.11	1 /	2	0.35	0.203	NC		700	NA	No	· Less than KBC
1,4-Dichlorobenzene	0.098 - 0.098	1 /	2	0.48	0.265	NC		27	NA	No	Less than RBC
Fluoranthene	0.068 - 6.4	1 /	6	0.13	1.23	NC	-	310		NO	Less than RBC
Phenanthrene	0.033 - 6.4	1 /	6	0.067	1.21	NC		160	<u>NA</u>	NO	Less man RBC
Ругепе	0.033 - 6.4	1 /	6	0.096	1.22	NC		230	NA	NO	
PAL VOLATILE ORGAN	ICS				0.00(0			160	×14	Nla	Less than RBC
Chlorobenzene	0.0009 - 0.0009	1 /	2	0.012	0.0062	NC		100	INA NA	No.	Less than RBC
Trichloroethylene	0.0028 - 0.0028	1 /	2	0.0042	0.0028	NC		56	NA.	190	
					<u> </u>						
OTHER	· · · · · · · · · · · · · · · · · · ·	and Some start and the second	Sac.91. (783	and the second state of th		110110400 (MILLION 10 10 10 10 10 10 10 10 10 10 10 10 10	and the second states which	No. 60 THE REAL PROPERTY OF	TA	37	Wostandard available
Lotal Petroleum Hydrocarbo	ons' estate a set	21	×2	951	923	NC NC		NA	AN	. I es	TV JUNCET AVAILABLE
VPH Ranges	nia waawaa waxaa waxa	AND A SHARE OF A MERICAN A MARKED A	10.000 Million	WARD DOCTOR	and half the second state of the	21.094 940866 0059560	era general a constant	MARINA PARAMANANA TANAN	AT 4	×7	No standard available
C9-G12 Aliphatics'		4 /			211	NC		NA		Ies Ve-	No standard available
C9-C10 Aromatics		<u> </u>	0	000	110	NU		NA.	-nA	LCS	TO ANIMALY & AVAILAND

TABLE 9-7 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS



NOTES:

* Based on samples from \$7S-98-13F, \$7S-98-14F, \$7S-98-13X, \$7S-98-14X, EX\$7F03X, EX\$7W14X, EX\$7W15X, and EX\$7W16X

* USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)

* Value for chlordane used as a surrogate,

" Value for naphthalene used as surrogate.

* For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

*Background: Maximum concentration in Fort Devens background listed; See Appendix F for development of background. **Region III RBCs (USEPA, 1999): Residential RBC for soil used for surface soil evaluation RBCs based on carcinogenic effects are associated with a 1×10° cancer risk level; RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

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* Less than RBC - Maximum detected concentration is less than risk-based concentration.

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, polassium, sodium) and is not considered a CPC.

* Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based Concentration mg - milligram kg - kilogram - Not applicable ARARs - Applicable or Relevant and Appropriate Requirements MCL - Maximum Contaminant Level SQL - Sample Quantitation Limit NA - No value available ND - Not detected NC - Not acleulated because there are fewer than 10 samples. PAL - protject analyte list UCL - upper confidence timit CPC - contaminant of concern

TABLE 9-8 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 INDUSTRIAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Range	Frequency		Concentrat	lon -				and the second second	The second state of the second state of the	and so is
ed. He was a final state of the first	of	of	Maximum Ar	ithmetic	95%	Back-	Region III				
A CALL STORE STORE A CALL STORE	SQLs	Detection	Detected	Mean	UCL	ground*	RBC**	ARARs	CPC?	Notes	
SUBSURFACE SOIL (2 - 15 feet)	bgs) (mg/kg) *										
	<u></u>						<u> </u>				
PAL METALS				24/0							
Aluminum	ANALY OF THE PARTY	4 / 4	4620	3440	NC	18000	7800	NA	No	'Less than RBC, ' Background	
Arsenic	Cold Al 28 Al Statistics	4 / 4	9.8/	9.7	<u> </u>	19,	0.43	NA	Yes	Exceeds RBC, Background	66 8 8 A
Barium		4 / 4	17.6	11.5	NC	54	550	NA	No	Less than RBC, ' Background	
Calcium		4 / 4	477	337	NC	810	NA	<u>NA</u>	No	Background, * Essential Nutrient	
Chromium	4.05 - 4.05	2/4	14	6.61	NC	33	23	NA	No	¹ Less than RBC, ² Background	
Cobalt		4 / 4	3.79	2.68	NC	4.7	470	NA	No	Less than RBC, ¹ Background	
Copper		4 / 4	8.42	5.41	NC	13.5	310	NA	No	Less than RBC, ' Background	
Iron		4 / 4	8080	6050	NC	18000	2300	NA	Yes	* Exceeds RBC, * Background	
Lead		4 / 4	2.96	2.39	NC	48	NA	400 *	No	Less than ARARs' Background	
Magnesium		4 / 4	1930	1350	NC	5500	NA	NA	No	* Background, * Essential Nutrient	
Manganese Managanese Managanese		4 / 4	231	151	NC	380	160	NA	Yes	*Exceeds RBC, * Background	
Nickel		4 / 4	12	7.74	NC	14.6	160	NA	No	'Less than RBC, 2 Background	Constant Service Science
Potassium		4/4	742	488	NC	2400	NA	NA	No	² Background, ⁴ Essential Nutrient	
Sodium		4 / 4	309	260	NC	131	NA	NA	No	* Essential Nutrient	<u> </u>
Vanadium	3.39 - 3.39	3 / 4	8.5	5.11	NC	32.3	55	NA	No	Less than RBC, 2 Background	
Zinc	8.03 - 8.03	3 / 4	19.8	12.5	NC	43.9	2300	NA	No	Less than RBC, ' Background	
											<u> </u>
PAL VOLATILE ORGANICS							·····			······································	
Trichlorofluoromethane	0.0059 - 0.0059	3 / 4	0.013	0.0075	NC		2300	NA	No	Less than RBC	
											<u> </u>
OTHER									·····		
Total Petroleum Hydrocarbons		<u>A</u> [<u>A</u>	121	68	NC		NA	NA	Vec	No standard available	
		C. C. S. S. MARLEY	and the second	and a state of the	and the second	Copr. and Sec. (1976)	COLORADOR AND COLORADOR				Marth Marthales
L <u> </u>						······	······			<u></u>	·····
NOTES:											
*Based on samples from 57B-95-01X, 57B-95-0	2X, 57E-95-01X, 57E-95-042	х.					Chemica	is selected as CPCs	are shaded.		
* USEPA soil lead screening level (OSWER Dire	ctive 9355.4-12, 1994b)						RBC - R	isk-based concentr	ation		
For calculation of the CPC for TPH see Table	9. 						mg - mi	ligram			
Background: Maximum concentration in Fort L	Jevens background listed;						Kg - Kuo	gram put mound surface			
**Region III RBCs (LISEPA 1990), Desidential	RAC for coil used for enhourt	ace soil evaluation					50L - 5	ow globald surrect	Limit		
RBCs based on careinogenic effects are associate	d with a 1x10"cancer risk lev	ci;					NA - No	value available			
RBCs based on noncarcinogenic effects are adjusted for a larget HQ of 0.1 (USEPA, 1999). ND - Not detected											
							NC - No	t calculated because	e there are few	er than 10 samples.	
Less than RBC - Maximum detected concentrat	ion is less than risk-based con	centration					Not :	pplicable			
 Exception - Sample concentrations detected and Exception - Maximum detected	re at or below background con	centra(1685.					PAL - p	roject analyte list	•		
EXECUTED REP VIANIMUM DEVELUE CONCENTRATION EXECUTED TO A SECONDERVISION FOR THE AND A CONSTRUCT A											
Less than ARARs - Maximum detected concent	ration is less than concentratio	on shown in ARARs color	110.				AKAKS	- Applicable of Kell	evani and App em	ropnate Redineura	
"Exceeds ARARs - Maximum detected concentra	ation is greater than concentral	tion shown in ARARs col	шпл.				46.00	Containentiese of CONC			

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

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TRBLE 9-9 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SUBSURFACE SOIL

	Range	Frequency	C	oucentratio	n –	State Barris			th <u>ais</u> air a	
and the second second	of	of	Maximum	Arithmetic	95%	Back-	Region III			and the second
And the second second second second	SQLs	Detection	Detected	Mean	UCL	ground*	RBC**	ARARs	CPC?	Notes
SUBSURFACE SOIL (2 - 15 fee	et bgs) (mg/kg)				<u> </u>					
DAT METALS			<u>-</u>							······································
Aluminum	CONTRACTOR CONTRACTOR	10 10	0040	5110	6070	18000	7900	NI A	Vac	² Evreeds RBC ABackmound
Arrowin		01 / 01		0/6	0370	10000	0.43		Vac	Exceeds REC
Barium	5 18 - 5 18	0 / 12	116	30.8	156	54	550	NA	No	Less than RBC
Calcium	100 - 100	8 / 10	1100	513	2620	810		NA	No	⁴ Essential Nutrient
Chromium	405-405	5 / 10	2010	515	8350	010 () () () () () () () () () () () () () (73	NA NA	Vac	Parende RBC
Cobalt	1 42 - 1 42	4 / 10	47	1 59	3	47	470	NA NA	No	Less than RBC 2 Background
Copper	0.965 - 0.965	11 / 12	17.6	6.83	17.8	13.5	310	NA	No	'Less than RBC
Iron	0.905 - 0.905		6880	4780		18000	2300	NIA NA	Vec	Exceeds RBC Backernund
Lead	Contract of the second s	12 / 12	5060	484	30,600	20000	NA	400-	Vec	Exceeds ARARs
Magnesium	100 - 100	9 / 10	1560	716	2720	5500	NA	NA	No	*Essential Nutrient. 3 Background
Manganese		12 / 12	175	62.3	169	380	160	NA	Yes	Exceeds RBC Background
Nickel	1.71 - 1.71	8 / 10	8.26	4.98	12.2	14.6	160	NA	No	¹ Less than RBC, ² Background
Potassium	100 - 100	9 / 10	386	250	424	2400	NA	NA	No	*Essential Nutrient. 2 Background
Selenjum	0.25 - 0.25	6 / 10	1.22	0.536	1.58	ND	39	NA	No	Less than RBC
Silver	0.589 - 0.589	1 / 10	0.959	0.361	0.458	0.086	39	NA	No	' Less than RBC
Sodium		10 / 10	726	503	626	131	NA	NA	No	⁴ Essential Nutrient
Vanadium	3.39 - 3.39	6 / 10	11.9	6.25	16	32.3	55	NA	No	1 Less than RBC, 2 Background
Zinc	8.03 - 8.03	8 / 12	753	87.5	550	43.9	23000	NA	No	' Less than RBC
	····		· · · · · · · · · · · · · · · · · · ·		·····			·······		
PESTICIDES/PCBS	······································						······			
4,4'-DDD	0.0083 - 0.0083	2 / 12	0.044	0.0094	0,0159		2.7	NA	No	Less than RBC
4,4'-DDT	0.0071 - 0.0071	1 / 12	0.0352	0.0062	0.0086		1.9	NA	No	Less than RBC
Endosulfan I	0.006 - 0.006	1 / 12	0.081	0.0095	0.0141		47	NA	No	Less than RBC
Dieldrin	0.0063 - 0.0063	2 / 12	0.043	0.0072	0.0113	e 10	0.04	NA	Yes	³ Exceeds RBC
Aroclor - 1248	0.082-0.082	1 / 12	3.2	0.304	0.482	19 (m	0.32	NA	Yes	¹ Exceeds RBC
Aroclor - 1260	0.0804 - 0.0804	4 / 12	12	2.09	156		0.32	NA	Yes	³ Exceeds RBC
PAL SEMIVOLATILE ORGAN	NICS									
2-Methylnaphthalene	0.049 - 2	1 / 12	6	0.696	9.49		160	NA	No	Less than RBC
Fluoranthene	0.068 - 3	1 / 12	0.7	0.325	2.23		310	NA	No	' Less than RBC
Naphthalene	0.037 - 1	1 / 12	6	0.626	7.61		160	NA	No	'Less than RBC
Pheneanthrene	0.033 - 1	1 / 12	0.3	0.154	1.13		160 °	NA	No	Less than RBC
Рутепе	0.033 - 1	1 / 12	0.6	0.179	1.54		230	NA	No	¹ Less than RBC
							-			
PAL VOLATILE ORGANICS										
1,2-Dichloroethylene (Total)	0.003 - 0.003	1 / 12	0.0039	0.0017	0.002		70	NA	No	Less than RBC
Acetone	0.017 - 0.017	4 / 12	0.067	0.0197	0.0354		780	NA	No	Less than RBC
Ethylbenzene	0.0017 - 0.0017	2 / 12	0.051	0.0054	0.0114		780	NA	No	Less than RBC
Tetrachloroethylene	0.00078 - 0.00078	2 / 12	0.0059	0.001	0.0018		12	NA	No	Less than RBC
Toluene	0.00081 - 0.00081	3 / 12	0.023	0.0033	0.0128		1600	NA	No	Less than RBC
Trichloroethylene	0.0028 - 0.0028	1 / 12	0.011	0.0022	0.003		58	NA	No	Less than RBC
Xylenes	0.0015 - 0.0015	1 / 12	0.27	0.0232	0.0488		16,000	NA	No	Less than RBC

TABLE 9-9 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

of Maximum Arithmetic 95% Back- Region III Detection Detected Mean UCL ground* RBC** ARARs CPC?

– NA NA

Concentration

OTHER

Total Petroleum Hydrocarbons* 28-28 11 / 12 31,800 8740 NC

 VPH Ranges

 C9-C12 Aliphatics'
 2
 /
 2
 NC

EPH Ranges

 C9-C18 Aliphatics*
 33 - 33
 1
 /
 2
 110
 63.2
 NC
 NA
 NA
 Yes
 'No standard available

 C19-C36 Aliphatics*
 2
 /
 2
 3,300
 1960
 NC
 NA
 NA
 Yes
 No standard available

 C11-C22 Aromatics*
 2
 /
 2
 990
 565
 NC
 NA
 NA
 Yes
 No standard available

NOTES:

Based on samples from 57E-95-13X (5f), 57E-95-14X (6f), 57E-95-15X (2f), 57E-95-16X (2f), 57E-95-18X (2f), 57E-95-19X (2f), 57E-95-20X (5f), 57E-95-03X (2f), 57E-95-05X (2f), 57E-9

Frequency

10 TH 10 TH

Value for naphthalene used as surrogate.

" For calculation of the CPC for TPH and EPH/VPH fractions see Table@.

* Exposures to petroleum are evaluated using EPH/VPH data. See appendix @.

*Background: Maximum concentration in Fort Devens background listed;

See Appendix F for development of background.

**Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation.

RBCs based on carcinogenic effects are associated with a 1x10" cancer risk level;

RBCs based on noncarcinogenic effects are associated with an adjusted HQ of 0.1 (USEPA, 1999).

1 Less than RBC - Maximum detected concentration less than risk-based concentration

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

" Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

Range

of

SQLs

' Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration mg - milligrams kg - kilograms ARARs - Applicable or Relevant and Appropriate Requirements bgs - below ground surface SQL - Sample Quantitation Limit NA - No value available - - Not applicable PAL - project analyte list UCL - upper confidence limit CPC - Contaminant of concern DDD - dichlorodiphenyldtichloroethane DDT - dichlorodiphenyltichloroethane Notes

Yes No standard available

NA NA Yes No standard available

TABLE 9-10 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 INDUSTRIAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Range	Frequency		Concentr	ation	8 (h (h (h (and the second second			
	of	of	Maximum	Arithmetic	95%	Back-	Region III	1010	cincle	
	SQLs	Detection	Detected	Mean	UCL	ground*	RBC**	AKAKS	ere?	inoies
SUBSURFACE SOIL (2 - 15 feet	bgs) (mg/kg)									
										· · · · · · · · · · · · · · · · · · ·
PAL METALS			6(10	1665	NC	19000	7000	NA	No	1 Less than RBC 1 Background
Aluminum	C. Annual State of Annual Coll (1994) - Market (2004)	3/3	0.67	4003	NC	10000	7600 0.43	NA	Vac	Excepts RBC
Arsenic		3/3	9,07	14.6	NC	5/	550	NA	No	¹ Less than BBC. ² Background
Barium		3/3	1780	14.0	NC	810		NA	No	* Essential Nutrient
Calcium		3/3	1380	<u> </u>	NC	33	23	NA	No	¹ Less than RBC ² Background
Chromium		3/3	1.51	0.12	NC		470	NA	No	¹ Less than RBC ³ Background
Cobalt	1.4 - 1.4	2/3	2.1	6.10	NC	4.7	210	NA	No	Less than RBC 2 Background
Copper		3/3	D.48	5.19	INC.	C.CI	010	ATA	INU	And Records RBC A Background
Iron			6410	5760	NO NO	18000	2300	INA NA	1 C5	² Background ⁺ Escential Nutrient
Magnesium		3/3	1340	1200	NC	0000	160		No	Less than BBC 2 Background
Manganese		3/3	65.2	60.6	NC	086	160		INU	Less than PBC 3 Background
Nickel		3/3	7.3	6.81	NC	14.0	100		No.	2 Background 4 Eccential Nutrient
Potassium		3/3	742	611	NC	24000	NA		NO	Less than PPC
Silver	0.59 - 0.59	2/3	4.46	1.96	NC	0.086	39	NA	NO	A Execution Nutricet
Sodium		3/3	555	533	NC	131	NA		NO	Li section BDC 2 Background
Vanadium		3/3	7.99	7.01	NC	32.3	55	NA	NO	Less than RBC, Background
Zinc		3/3	18.3	17.2	NC	43.9	2300	NA	NO	· Less than KBC, · Dackground
PESTICIDES/PCBs										Line the DDC
4,4-DDD	0.0003 - 0.0083	1/9	0.024	0.0041	NC	**	2.7	NA	NO	Less man RDC
Aroclor - 1260	0.0017 - 0.0804	4/9	0.26	0.053	NC		0.32	NA	No	
PAL VOLATILE ORGANICS							1 600			Li con them BBC
Toluene	0.0008 - 7	2/9	0.0018	2.22	NC		1600	NA	_INO	
Xylenes	0.0015 - 9.3	1/9	0.0069	2.95	NC		16000	NA	NO	
							,			
OTHER				a Maran - Min Webs		NAME AND TAKEN ADDRESS OF ADDRESS	and the second	and the second	materia) - A matabo	
Total Petroleum Hydrocarbons	-28 - 28	1/3	25	17.7	NC	8 8 8 -	NA	NA	Yes	INO Standard available
EPH Ranges						The second second second second	THE REAL PROPERTY AND A VALUE OF THE PARTY		2.2000 (Star 14-74) (Star)	
C9-C18 Aliphatics	6.3 - 7.6	2 / 6	- 78	16.7	NG		NA	NA	Yes	tyo stalloard available
C19-C36 Aliphatics	. 6.3 - 6.3	5 / 6		246	NC	e serve - -	NA	NA	Yes	No standard avaliable
C11-C22 Aromatics	17-20	2 / 6	110	30.4	NC	19 Concernantes	NA	NA	Yes	INO STANDARD BYALLADIC

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TABLE 9-10 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 INDUSTRIAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Range Frequency Concentration of of Maximum Arithmetic 95% Back Region III. SQLs Detection Detected Mean UCL ground* RBC**	ARARS CPC? Notes
NOTES:	
"Based on samples from 57B-96-08X (5 ft), 57B-96-09X (5 ft), 57B-96-11X and Dup (10 ft), EX57W06X (5 ft), EX57W07X (5 ft),	Chemicals selected as CPCs are shaded.
EX57W08X (5 (1), EX57W09X (4 (1), EX57F01X (6 (1), and EX57F02X (8 (1).	RBC - Risk-based Concentration
* For calculation of the CPC for TPH and EPH/VPH fractions see Table@.	ng - milligram
*Background: Maximum concentration in Fort Devens background listed;	kg - kilogram
*Recion III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation	- Not applicable
RBCs based on carcinogenic effects are associated with a 1x10" cancer risk level;	ARARs - Applicable or Relevant and Appropriate Requirements
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).	SQL - Sample Quantitation Limit
	NA - No value available
Less than RBC - Maximum detected concentration is less than risk-based concentration.	ND - Not detected
* Background - Sample concentrations detected are at or below background concentrations.	NC - Not calculated because there are fewer than 10 samples.
* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.	PAL = protject analyte list
* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.	UCL - upper confidence limit
Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.	CPC - contaminant of concern
* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.	
' No standard available - No RBC or ARARs available, therefore analyte is a CPC.	

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TABLE 9-11 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		Children and Chi	1. 1. 1. A A A A.	and the	
of of <u>Maximum</u> Arithmetic 95% B	ack- F	Region III.	ADARs	CPC2	Notes
SQLS Detection Detected weam OCD gro	uunu 🤄 👘	VDC-	ANAIO	<u> </u>	. Notes
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg) ²					
PAL METALS					
Arsenic 1 / 1 28.2 28.2 NC	19	. 0.43	NA	Yes	¹⁴ Exceeds RBC
Barium 1 / 1 13.1 13.1 NC	54	550	NA	No	¹ Less than RBC, ² Background
Copper 1 / 1 2.2 2.2 NC	13.5	310	NA	No	Less than RBC, ² Background
Manganese 1 / 1 70.8 70.8 NC	380	160	NA	No	' Less than RBC, ' Background
Selenium 1 / 1 5.89 5.89 NC	ND	39	NA	No	¹ Less than RBC
Zinc 1 / 1 13.3 13.3 NC	43.9	2300	NA	No	¹ Less than RBC, ² Background
					·····
PAL SEMIVOLATILE ORGANICS					
Bis(2-ethylhexyl)phthalate 1 / 1 14 14 NC		46	NA	No	Less than RBC
PAL VOLATILE ORGANICS					
1 1 1-Trichlorosthane 1 / 1 0.013 0.013 NC		160	NA	No	¹ Less than RBC
Toluene 1 / 1 0.0013 0.0013 NC		1600	NA	No	Less than RBC
Xylenes 1 / 1 0.0041 0.0041 NC		16,000	NA	No	'Less than RBC

NOTES:

"Based on samples from 57S-98-15F and 57S-98-15X.

Background: Maximum concentration in Fort Devens background listed;
See Appendix F for development of background.
*Region III RBCs (USEPA, 1999): Residential RBC for soil used for subsurface soil evaluation RBCs based on carcinogenic effects are associated with a 1x10⁻⁻⁻ cancer risk level;
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

Less than RBC - Maximum detected concentration is less than risk-based concentration.

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, polassium, sodium) and is not considered a CPC.

Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based Concentration mg - milligram kg - kilogram - Not applicable or Relevant and Appropriate Requirements MCL - Maximum Contantinant Level SQL - Sample Quantitation Limit NA - No value available ND - Not detected NC - Not calculated because there are fewer than 10 samples. PAL = protject analyte list UCL - upper confidence limit CPC - contaminant of concern

TABLE 9-12 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 INDUSTRIAL USE GROUNDWATER

Contraction of the State of the	Range	Frequency		Concentra	tion 👋 '		Collision of		1.00	and a constant of the second second second second
HERE AND AND AND ADDRESS	of	of _	Maximum	Arithmetic	95%	Back-	Region III	and the second	-	
and a state of the second state of the	SQLs	Detection	Detected	Mean	UCL	ground*	RBC**	ARARs***	CPC?	Notes
GROUNDWATER - UNFILTE	RED (µg/L)									
PAL METALS				(A	und an in the form	I MARINE WILLIAM AND			MARCHINE POR AND	S Description D & D & Description D D G D and an and a second second second second second second second second
Ahuninum	141 - 141	1/2	204	137	NC	6870	3/00	30 3	res	Lass then BPCAL ass then APAP. Provide mound
Barium		2/2	18.6	15.8	NC	39.6	260	2000 -	NO	d Basastial Nutrient & Baskground
Calcium		2/2	5010	4900	NC	14700	NA	NA	No	Essential Nourient, - Background
Manganese		2/2	177	91.4 .	NC	291	/3	SU	Yes:	A Facebook RBC Exceeds ARAR
Potassium		2 / 2	1560	1440	NC	2370	NA	NA	NO	A Background
Sodium		2/2	9000	5900	NC	10800	NA	NA	No	Essential Nutrient, - Background
PAL SEMIVOLATILE ORGAN	NICS	1 10	23	1.95	NC		2000	NA	No	Less than RBC
Diethyl Phthalate	2-2	1 / 2		1.65	INC.		2900	10	110	
PAL VOLATILE OPCANICS										
Talvene	05-05	1 / 2	1.2	0.73	NC		75	1000	No	'Less than RBC.' Less than ARAR
	010 010	<u> </u>								
OTHER										
Nitrite/Nitrate		2 / 2	2000	1435	NC		NA	· 10000 *	No	⁴ Less than ARAR
Chloride	2120 - 2120	1 / 2	13200	7130	NC		NA	250000 4	No	' Less than ARAR
GROUNDWATER - FILTEREI	Ο (μg/L) "									
DAT METALS										
Aluminum	41-141	1/2	167	118.8	NC	6870	3700	50 *	Yes	Less than RBC*Exceeds ARAR*Background
Barium		2/2	17.2	15.6	NC	39.6	260	2000 *	No	¹ Less than RBC ³ Less than ARAR ² Background
Calcium		2 / 2	5320	4990	NC	14700	NA	NA	No	⁴ Essential Nutrient, ² Background
Magnesium	500 - 500	1 / 2	507	379	NC	3480	NA	NA	No	* Essential Nutrient, 2 Background
Manganese		2 / 2	173	89.5	NC	291	73″	50 4	Yes	Exceeds RBC. *Exceeds ARAR, *Background
Potassium	energiane (FBP) e prestre antre antre (FAP) e an	2/2	1660	1505	NC	2370	NA	NA	No	* Essential Nutrient, 2 Background
Sodium		2 / 2	10100	6430	NC	10800	NA	NA	No	* Essential Nutrient, * Background
Countin .										

TABLE 9-12 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 INDUSTRIAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Frequency Concentration Range Arithmetic 95% Back-Region III Maximum of , of RBC** ARARs*** CPC? Notes Detected Mean UCL ground* SQLs Detection

NOTES:

* Based on unfiltered samples taken in 1995 from 57M-95-05X, 57M-95-06X. * Based on filtered samples taken in 1995 from 57M-95-05X, 57M-95-06X. * MCL (USEPA, 1998) * Secondary MCL (USEPA, 1998)

*Background: Maximum concentration in Fort Devens background listed; 95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background. *Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundwater evaluation. RBCs based on carcinogenic efficits are associated with a 1x10"cancer risk level; RBCs based on nonearcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a). *** ARARs are primary or secondary MCLs.

' Less than RBC - Maximum detected concentration is less than risk-based concentration

* Background - Sample concentrations detected are at or below background concentrations.

2 Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

" Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration µg - micrograms L - liter SQL - Sample Quantitation Limit NA - No value available NC - Not calculated because there are fewer than 10 samples. - Not applicable PAL - project analyte list UCL - upper confidence limit ARARs - Applicable or Relevant and Appropriate Requirements CPC - Contaminate of Concern

TABLE 9-13 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE GROUNDWATER

	Range	Freque	ncy .	() () () () () () () () () ()	Concentration	i 🔆 👘		6 6 N 3			
and the second second second second	of	of		Maximum	Arithmetic 😁	95%	Back- F	Cegion III			
and the second second second second	SQLs	Detecti	ion	Detected	Mean	UCL	ground*	RBC**	ARARs***	CPC2	Notes
GROUNDWATER - UNFILTEREL) (µg/L)										
DAL METALS											
Arsenic 2	54-2.54	2 /	6	54,4	10.73	NC	10.5	0.045		'Yes	Exceeds RBC, 'Exceeds ARAR
Barium	AZ AN ALTER AND AN	6 /	6	27.6	14.4	NC	39.6	260	2000 •	No	¹ Less than RBC, ² Background, ⁵ Less than ARAR
Calcium	*	5 /	5	13600	8720	NC	14700	NA	NA	No	² Background, ⁴ Essential Nutrient
Iron 3	8.8 - 38.8	21	st 5 4	3610	876	NC	9100	1100	300" 4	Yes ,	Exceeds RBC, Background, Exceeds ARAR
Magnesium 5	00 - 500	4 /	5	1460	946	NC	3480	NA	NA	No	² Background, ⁴ Essential Nutrient
Manganese		5 7	5	724	368	NC	291	730	50	Yes	Less than RBC, Exceeds ARAR
Potassium		5 /	5	2800	1350	NC	2370	NA	NA	No	* Essential Nutrient
Sodium		5/	5	34900	17200	NC	10800	NA	NA	No	* Essential Nutrient
PESTICIDES/PCBs	10-010	C. 1992	Salation Constant	0.02	0 116	NC		0.033	0-5 °	Vec	*Exceeds RBC * Less than ARAR
Arocior-1260	.19-0.19	<u></u>	<u> </u>	U.LL	0.110	4100					
PAL SEMIVOLATILE ORGANICS											
Bis(2-ethylhexyl)phthalate	4,8 - 4,8	3, /	6	400	119	NC		4.8	6 *	Yes	*Exceeds RBC, * Exceeds ARAR
PAL VOLATILE ORGANICS											
1,2-dichloroethylene (total)	0.5~0.5	2 /	··· 6 ···	13	2.63	NC~		5.5	70 •	Yes	*Exceeds RBC, "Less than ARAR
Tetrachloroethylene	- 1.6 - 1.6	, 2 <i>i</i>	6	16	3.85	NC		1.1.	<u> </u>	Yes	*Exceeds RBC,*Exceeds ARAR
Toluene	0.5 - 0.5	5/	6	0.9	0.567	NC		75	NA	No	'Less than RBC
Trichloroethylene	0.5 - 0.5	3.1	6 🔍	1.9	0,86	NC		1.6	5.*.	Yes	- Exceeds RBC, Less than ARAR
OTHER											· · · · · · · · · · · · · · · · · · ·
Nitrata/Nitrita		5 /		1800	1070	NC		NA	10000 °	No	'Less than ARAR
Nitrogen	183-183		5	313	140	NO		NA	NA	Yes	*No standard available
Phoenbate	133-133	21	5	15	9.75	NC	1	NA	NA	Yes	'No standard available
Chloride		5 /	5	63000	26200	NC		NA	250000 *	No	³ Less than ARAR
Sulfate	10.000 - 10.000	4 /	5	21000	14600	NC		NA	250000 4	No	³ Less than ARAR
GROUNDWATER - FILTERED (HE	;/L) °										
			-								
PAL METALS			the second second		1.5.4 million and an Owner (State	0.000		See	AT A MERICA		I Reemade DDI
Arsenic	2.54 - 2.54	2.1	67	/3	13.7	NG	10.5	0.045	NA NA	Nic Nic	Uses than BBC ? Background
Barium		6 /	6	27.7	14.6	NC	39.0	200	NA NA	NO	⁴ Eccential Nutrient ² Background
Calcium	and the state of the life base of the Conference of the second	5 /	5	12700	8610	NC	14700	NA	NA.	NO	Essential Hudelin, Dackground
Iron	38.8-38.8	289	<u>, 5</u>	3530	800	NU	2480	NA	NA NA	No	4 Recential Nutrient 2 Background
Magnesium	500 - 500	4 /	5	1370	941	NC	548U	NA m	NA XXX	INO Miles Viewer	Provede RBC
Manganese			<u></u>	819	066.	NC	27.0	NIA	NA	No	⁴ Essential Nutrient
Potassium		<u> </u>	<u> </u>	2990	17000	NC	10900	NA NA	MA	No	* Essential Nutrient
Sodium		5 /	2	34300	17000	NC.	10000	11/1	11/1	110	

TABLE 9-13 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

 Range
 Frequency
 Concentration

 of
 of
 Maximum
 Arithmetic
 95%
 Back Region III

 SQLs
 Detection
 Detected
 Mean
 UCL
 ground*'
 RBC**
 ARARs***
 CPC?
 Notes

NOTES:

Based on unlittered samples taken in 1995 and 1998 from 57M-95-04A, 57M-95-04B, 57M-95-07X, 57M-95-08A, 57M-95-08B, 57P-98-02X.
Based on filtered samples taken in 1995 and 1998 from 57M-95-04A, 57M-95-04B, 57M-95-07X, 57M-95-08A, 57M-95-08B, 57P-98-02X.
*MCL (USEPA, 1998)

"Secondary MCL (USEPA, 1998)

* The value for cis-1,2-dichloroethylene was used because it is the most conservative value.

*Background: Maximum concentration in Fort Devens background listed;

95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background.

**Region III RBCs (USEPA, 1997a): Tanwater RBCs used for groundwater evaluation.

RBCs based on careinogenic effects are associated with a 1x10° cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a).

*** ARARs are primary or secondary MCLs.

* Less than RBC - Maximum detected concentration is less than risk-based concentration

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

* Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

" Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

"No standard available - No RBC or ARARs available, therefore analyte is a CPC.

" No standard available - No RHC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration ARRAs - Applicable or Relevant and Appropriate Requirements µg - micrograms L - liter SQL - Sample Quantitation Limit NA - No value available - • Not calculated because there are fewer than 10 samples. PAL - project analyte list UCL - upper confidence limit CPC - Contaminant of concern

TABLE 9-14 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 INDUSTRIAL USE GROUNDWATER

	Range	Frequency		Concentra	ation					
	of	of 7	daximum Ar	lthmetic	95%	Back-	Region III		2 6.	
	SQLs	Detection	Detected	Mean	UCL	ground*	RBC**	ARARs***	CPC7	Notes
GROUNDWATER - UNFILTER	(ED (μg/L) *			<u> </u>						
DAY MOTATO										
PAL METALS	Service in Sector Sectors and the		100	138	NC	6870	3700	50 4	Vec	Tess than BBC Proceeds AB ARs Background
Aluminum	2.54 0.54	- 1/2	190	120	NC	3.03	0.045	50 *	Var	³ Exceeds RBC ³ Less than ARARs
Arsenic	2.34 - 2.34	2/2	87.7	57 /	NIC	30.6	260	2000 4	No	Less than RBC 11 ess than ARARs
Bariuni	2 01 2 01	112	867	5.00	NC	4 01	1.8	5 4	Vec	Exceeds RRC Exceeds ARARs
Calaium	10:01-0:01	2/7	8150	8050	NC	14700	NA	NA	No	⁴ Essential nutrient ² Background
Tran		2/2	12400	00.00	NC	0100	1100	300.4	Vec	*Exceeds RBC *Exceeds ARARs
Momentum	1000 1000	1/2	1110	805	NC	3480	NA	NA	Na	¹ Essential nutrient, ¹ Background
Magnesium	1000 - 1000	2/2	466	005 205	NC	201		50 4	Vac	*Exceeds RBC * Exceeds ARARs
Potossium		2 / 2	2400	1080	NC	2370	NA	NA	No	⁴ Essential nutrient
Zine	358 358	1/2	197	105	NC	211	1100	500 4	No	¹ Less than RBC, ³ Less than ARARs
Zine		., 2		105					110	
PAL SEMIVOLATILE ORGANI	ICS									
1,2-Dichlorobenzene	1.7 - 1.7	1 / 2	9.8	5.33	NC 🗠		6.4	600	Yes>	"Exceeds RBC, 'Less than ARARs
1.4-Dichlorobenzene	1.7 - 1.7	1/2	5.6	3.23	NC	19 1 - 19 2	0.47	5 5	Yes	* Exceeds RBC, * Exceeds ARARs
2-Methylnaphthalene	1.7 - 1.7	1 / 2	4.4	2.63	NC	_	12	NA	No	' Less than RBC
4-Methylphenol	0.52 - 0.52	1 / 2	1.5	0.88	NC	**	18	NA	No	Less than RBC
Naphthalene	0.5 - 0.5	1 / 2	20	10.1	NC	1	0.65	NA .	Yes	³ Exceeds RBC
PAL VOLATILE ORGANICS								entrale black bedden oan oan dit anne rada		
Carbon Tetrachloride	0.58 - 0.58	1 / 2	4.5	2.4	- <u>N</u> C		0.16	5 *	· Yes	Exceeds RBC
Chloroform	0.5 - 0.5	1/2	10	5.13	NC		0.15	5 *	Yes	*Exceeds KBC, *Exceeds AKARs
Dichloromethane	2.3 - 2.3	1 / 2	2.9	2.03	NC		4.1	NA	No	· Less than RBC
Ethylbenzene	0.5 - 0.5	1 / 2	46	23.1	NC	_	130	700 * -	No	'Less than RBC, 'Less than ARARs
Tetrachloroethene	1.6 - 1.6	1 7 2	2.6	1.7	NC	<u> </u>	1.1	5 *	Yes	*Exceeds RBC, *Less than ARARs
Toluene	0.5 - 0.5	1/2	19	9.63	NC		75	1000 *	No	Less than KBC, Less than ARAKs
Trichloroethene	0.5 - 0.5	1 / 2	0.59	0.42	NC		1.6	5 *	No	Less than KBC, ' Less than ARARs
Xylenes	0.84 - 0.84	1/2	200	100	NC		1200	10000 *	No	' Less than RBC, ' Less than ARARs
OTHER				_,						
Nitrite/Nitrate		1/1	158	158	NC		NA	10000 4	No	* Less than ARARs
Numerinitate	102 102		136	200	NO		NA	NA	Yes	⁷ No Standard
INIDOgen	103-103	1/2	28.6	200	NC		NA	NA NA	Vec	'No Standard
VBH Danges		21	40.0					1111	100.000.00	
CO CIO Argentica	Constant of the local sector of the	1 / 1	310	310	NC		NA -	NA	Vec	'No Standard
69-CIO Aromaucs	AND STANK STATE	State of the second sec		NUM PICK	and a		1111	and the design of the second	APRIX AN	

TABLE 9-14 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 INDUSTRIAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Range Frequenc	y .	Concent	tration 🚿					
6. 他们将他们将他们的有限。	of of	Maximun	n Arithmetic	95%	Back-	Region III			위에는 사람이 같은 것은 것은 것은 것은 것은 것이 같은 것을 것이다.
·····································	SQLs Detection	n Detected	Mean	UCL	ground*	RBC**	ARARS***	CPC?	Notes
GROUNDWATER - FILTERED (µg/	L) [*]	······································				· · · ·			
PAL METALS									
Arsenic	\cdot	7.1 • • • • • • • • • • • • • • • • • • •),1 38,4	I NC	10.5	0.045	-~ 50, *	Yes	*Exceeds RBC, *Less than ARARs
Barium	1	/1 37	7.4 36.9) NC	39.6	260	2000 •	No	Less than RBC, ' Less than ARARs, ' Background
Calcium	1	/ 1 101	00 9960) NC	14700	NA	NA	No	² Background, ⁴ Essential Nutrient
Iron		/ 1	00 11000) NC	9100	1100	.300 4	Yes	*Exceeds RBC, * Exceeds ARARs
Magnesium	1	/1 7	75 744	NC NC	3480	NA	NA	No	² Background, ⁴ Essential Nutrient
Manganese	1	/ 1 - 3	51	NC-NC-	291	73	50 *	Yes	* Exceeds RBC, * Exceeds ARARs
Potassium	1	/ 1 23	70 2120) NC	2370	NA	NA	No	² Background, ⁴ Essential Nutrient
Sodium	1	/ 1 19	50 1930) NC	10800	ŇĂ	NA	No	² Background, ⁴ Essential Nutrient
Zinc	1	/ 1 46	.3 44.8	I NC	21.1	1100	5000 4	No	Less than RBC, ' Less than ARARs

NOTES:

* Based on unfiltered samples taken in 1995 and 1996 from 57M-95-03X and 57M-96-09X.

* Based on filtered samples taken in 1995 from 57M-95-03X and its duplicate.

*MCL (USEPA, 1998)

"Secondary MCL (USEPA, 1998)

*Background: Maximum concentration in Fort Devens background listed;

95 percent UCL of Fort Devens background groundwater. See Appendix F for development of background.

**Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundwater evaluation.

RBCs based on careinogenic effects are associated with a 1x10"cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1997a).

*** ARARs are primary or secondary MCLs.

* Less than RBC - Maximum detected concentration is less than risk-based concentration.

* Background - Sample concentrations detected are at or below background concentrations.

* Exceeds RBC - Maximum detected concentration exceeds risk-based concentration.

* Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

"Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

' No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based Concentration µg - microgram L - liter - Not applicable ARARs - Applicable or Relevant and Appropriate Requirements MCL - Maximum Contaminant Level SQL - Sample Quantitation Limit NA - No value available ND - Not value available ND - Not detected NC - Not calculated because there are fewer than 10 samples. PAL= project analyte list UCL - upper confidence limit CPC - contaminant of concern

g:\projects\usaec\projects\57ritabl\\hhrisk\revised\573I-CPC.xls

TABLE 9-15 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Frequency Concentration	T se si
of Maximum Arithmetic 95% Back- Region III	
Detection Detected Mean UCL ground* RBC** ARARs*** CPC	?? :/~!`

GROUNDWATER - UNFILTERED (µg/L)*

Range

lo

SQLs

PAL METALS										
Aluminum		3./3	2450	899	NÇ.:	6870	3700	50 4	Yes	"Less than RBC, "Exceeds ARAR, "Background
Arsenic	2.54 - 2.54	5 / 6	84.4	19.8	NC	10.5	0.045	50 5	Yes	*Exceeds RBC, *Exceeds ARAR
Barium		6/6	41.8	23.1	NC	39.6	260	2000 °	No	' Less than RBC,' Less than ARAR
Calcium		3 / 3	16,900	9340	NC	14,700	NA	NA	No	⁴ Essential Nutrient
Copper	5.0 - 5.0	1/6	8.54	3	NC	8.09	150	1300 f	No	¹ Less than RBC, ² Less than ARAR
Iron		3/3	1910	1190	NC	9100	1100	300 *	Yes	*Exceeds RBC, *Exceeds ARAR, Background
Magnesium	1000 - 1000	1 / 3	1080	693	NC	3480	NA	NA	No	* Essential Nutrient
Manganese		3 / 3	346	226	NC	291	73	50 4	Yes	*Exceeds RBC, * Exceeds ARAR
Potassium	1000 - 1000	2 / 3	1730	1290	NC	2370	NA	NA	No	⁴ Essential Nutrient
Sodium	2290 - 2290	2 / 3	5050	3020	NC	10,800	NA	NA	No	⁴ Essential Nutrient
Zinc	35.8 - 35.8	I/6	37.2	21.1	NC	21.1	1100	5000 4	No	¹ Less than RBC, ³ Less than ARAR
PAL SEMIVOLATILE ORG.	ANICS									
1,2-dichlorobenzene	1.7 - 1.7	2/6	6.4	2.24	NC	-	6.4	600 °	No	³ Less than ARAR
1;4-dichlorobenzene	1.7 - 1.7	1/6	2.7	1	NC		0.47	5 ``	-Yes	*Exceeds RBC, *Less than ARAR
2-methylnaphthalene	1.7 - 1.7	1/6	2	1.04	NC	**	12	NA	No	¹ Less than RBC
4-methylphenol	0.52 - 0.52	1 / 6	5	1.05	NC		18	NA	No	¹ Less than RBC
Bis(2-ethylhexyl)phthalate	4.8 - 4.8	2/6	52	11.2	NC	6.0 (d 0.0) - (-)	4.8	6 *	Yes	* Exceeds RBC, * Exceeds ARAR
Naphthalene	0.5 - 0.5	2 / 6	13 -	2.13	NC		0,65	NA	Yes	*Exceeds RBC
PAL VOLATILE ORGANICS	S									
Chlorobenzene	0.5 - 0.5	1/6	0.88	0.355	NC		11	100 *	No	¹ Less than RBC, ³ Less than ARAR
Ethylbenzene	0.5 - 0.5	3/6	20	4.46	NC		130	700 '	No	'Less than RBC,' Less than ARAR
Styrene	0.5 - 0.5	1/6	8	1.54	NC		160	100 *	No	Less than RBC, ' Less than ARAR
Tetrachloroethene	1.6-1.6	1.76	-5.5	1.58	NC		1.1	: 5 5	Yes	*Exceeds RBC, *Exceeds ARAR
Toluene	0.5 - 0.5	2/6	2.9	0.833	NC		75	1000 *	No	Less than RBC,' Less than ARAR
Trichloroethylene	0.5 - 0.5	1.16	3.8	0.833	NC .		1.6	5 *	Yes	^a Exceeds RBC, ³ Less than ARAR
Xylenes	0.84 - 0.84	2/6	5.9	2.21	NC		1200	10,000 *	No	Less than RBC, ³ Less than ARAR
OTHER										
Nitrate/Nitrite		3/3	132	67.7	NC		NA	10,000 *	No	'Less than ARAR
Phosphate	13.3 - 13.3	· 1 / 3	55.2	22.8	NC		NA	NA	Yes:	'No standard available
VPH Ranges										
C5-C8 Aliphatics		-1.71	- 89,5	89.5	NC	• — · · · ·	NA -	NA	Yes	'No standard available
C9-C12 Aliphatics		1/1	42.5	42.5	NC	·	NA	NA	Yes	No standard available
C9-C10 Aromatics	A CONTRACT OF A	1 / 1	172	172	NC		NA NA	NA .	.Yes	No standard available

a service and the service of the ser

Notes

TABLE 9-15 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE GROUNDWATER

Range	Frequency		Concentra	ation									
lo	of	Maximum	Arithmetic	95% UCI	Back-	Region III	ARARs***	· CPC		Notes			
CROUNDINATED BILTEDED (Detection	Delected			Ground								
GROUNDWATER - FILTERED (µg/L)													
PAL METALS											"		
Arsenic	3 / 3	138	56.4	NC	1990 (1990 (1990)	0.045	50 *	Yes	*Exceeds RBC, *1	xceeds ARARs			
Barium	3/3	9.2	7.53	NC		260	2000 *	No	' Less than RBC, '	Less than ARARS	s, ² Background		
NOTES:													
Based on unfiltered samples taken in 1996 and 1998 from 57M-96-10.	X, 57M-96-11X and its (luplicate, 57M-96-123	, 57M-96-13X, \$7F	9-98-03X, and	57P-98-04X.								
Based on filtered samples taken in 1996 and 1998 from 57M-96-11X a	and its duplicate, 57P-98	03X, and 57P-98-042	-				Chemicals selected	l as CPCs are	shaded.				
"MCL (USEPA, 1996a)							RBC - Risk-based Concentration						
Secondary MCL (USEPA, 1996a)							µg - microgram						
*Background: Maximum concentration in Fort Devens background liste	d;						L - liter						
95 percent UCL of Fort Devens background groundwater. See Appendix	x F for development of b	ackground.					Not applicable						
**Region III RBCs (USEPA, 1997a): Tapwater RBCs used for groundw	vater evaluation.						ARARs - Applicable or Relevant and Appropriate Requirements						
RBCs based on carcinogenic effects are associated with a 1x10 ⁻⁶ cancer r	isk level;						MCL - Maximum Contaminant Level						
RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0).1 (USEPA, 1997a).						SQL - Sample Quantitation Limit						
*** ARARs are primary and secondary MCLs.							NA - No value available						
• • •							NC - Not calculate	d because the	are are fewer than 10,sample	<u>~</u> .			
¹ Less than RBC - Maximum detected concentration is less than risk-base	ed concentration.						PAL = protject ana	ilyte lîst					
² Background - Sample concentrations detected are at or below backgrou	nd concentrations.						UCL - upper confid	dence limit					
⁹ Exceeds RBC - Maximum detected concentration exceeds risk-based or	oncentration.						CPC - contaminant	l of concern					
⁴ Essential Nutrient - Analyte is an essential human nutrient (magnesium	, calcium, potassium, soc	lium) and is not consid	cred a CPC.										
⁵ Less than ARARs - Maximum detected concentration is less than conce	entration shown in ARAF	ts column.											
⁶ Exceeds ARARs - Maximum detected concentration is greater than con	centration shown in ARA	ARs column.											
⁷ No standard available - No RBC or ARARs available, therefore analyte	e is a CPC.												

TABLE 9-16 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SEDIMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

in the second		Frequency	Maximum			Upgradient				
	Range of	of Detection	Detected	Arithmetic	95%	Sediment	Region III	ADADE	CBC3	NOTES
	SQLS	PERCENT	Concentration	oltan	UCL	Concentration		AKAKO	CIC:	
SEDIMENT (mg/kg) *										· · · · · · · · · · · · · · · · · · ·
DAT MOTAT C									<u></u>	· · · · · · · · · · · · · · · · · · ·
A luminum		6/6	15 900	11.600	NC	12.400	7800	NA	YES	Exceeds RBC
Arsenic		9/9	220	70.2	NC	110	- 0.43	NA	YES .	Exceeds RBC
Barium	5.2 - 5.2	6/9	159	69.8	NC	101	550	NA	NO	Less than RBC
Cadmium	0.70 - 0.70	1/6	2.3	0.68	NC	NA	39	NA	NO	Less than RBC
Calcium		6/6	18,400	11,600	NC	9,890	NA	NA	NO	Essential Nutrient
Chromium	4:1-4,1	3/6	48.9	23.2	NC	40.6	23	NA NA	YES	Exceeds RBC
Cobalt	1.4 - 1.4	5/6	25.8	15.0	NC	21.2	470	NA	NO	Less than RBC
Copper	0.97 - 0.97	8/9	201	46.6	NC	30.7	310	NA	NO	Less than RBC
Iron		6/6	30,400	21,300	NC*	26,900	2300	NA	YES	Exceeds RBC
Lead	10.5 - 10.5	8/9	. 410	175	NC	208	NA	400*	YES *	Exceeds ARARs
Magnesium		6/6	4,480	3,133	NC	3,710	NA	NA	NO	Essential Nutrient
Manganese Marganese States and St	A State Collect M	9/9	3,940	1,200	NC	1,510	160	NA	YES	Exceeds RBU
Mercury	0,05 - 0.05	1/6	0.36	0.081	NC	0.20	2.3	NA	NO	Less than RBC
Nickel	1.7 - 1.7	5/6	42.9	29.3	NC	34.8	160	NA	NO	
Potassium	100 - 100	4/6	1,240	718	NC	934	NA	NA	NO	Essential Nutrient
Selenium	0.25 - 2.4	5/9	21.9	5.7	NC	2.8	39	NA		Less man RBC
Sodium		6/6	3,610	2,157	NC	1,150	NA	NA	NO	Essential Nutrient
Vanadium	3.4 - 3.4	4/6	40.3	22.9		34.7	55		NO	Less man RBC
Zinc	8 - 8	6/9	468	206	NC	315	2300	NA	NO	Less than RBC
		···•								· · · · · · · · · · · · · · · · · · ·
PESTICIDES/PCBs	0.0000 0.0007	2/0	<u></u>	0.15	NC	0.52		NA	NO	Less than RBC 2 Background
4,4-DDD	0.0083 - 0.0083	7/9	0.44	0.15		0.18	4.1	NA		¹ Less than RBC ² Background
4,4'-DDE	0.0077 - 0.0077	4/9	0.16	0.036	NC	0.002	1.9	NA	NO	Less than RBC Background
4,4-DDT	0.0071 - 0.0071	4/0	0.076	0.040	NC	0.092 NA	0.22	NA	NO	Less than RBC
Aroclor-1260	0.0804 - 0.0804	1/9	0.30	0.009	NC	NA NA	0.52	NA	- VEC	*Exceeds RBC
Dieldrin	0.0063 - 0.0063	4X ()	0.040	0.0090	JYC	NA	0.04	Philippine Providence	ومدد وي	
PAL SEMIVOLATILE ORGANICS										
Benzolkifikaranthene	0.066 - 1.0	3/9	3.0	0,58	NC	1.8	8.7	NA	NO	Less than RBC
Chrysene	0.12 - 2.0	2/9	1.2	0.47	NC	NA	87	NA	NO	Less than RBC
Fluoranthene	0.30 - 1.0	7/9	6.0	2.2	NC	5	310	NA	NO	Less than RBC
Phenanthrene	0.20 - 0.70	6/9	3.0	0.80	NC	2.3	160 *	NA	NO	¹ Less than RBC
Pyrene	0.70 - 0.70	8/9	6,0	2.3	NC	4.8	230	NA	NO	Less than RBC
PAL VOLATILE ORGANICS										
Acelone	0.017 - 0.017	4/9	0.31	0.080	NC	0.55	780	NA	NÖ	Less than RBC, 2 Background
Methylene chloride	0.012 - 0.012	1/9	0.15	0.022	NC	NA	85	NA	NO	¹ Less than RBC
Tetrachloroethene	0.0008 - 0.0008	2/9	0.078	0.010	NC	NA	12	NA	NO	Less than RBC
Toluene	0.0008 - 0.0008	4/9	0.020	0.0050	NC	NA	1600	NA	NO	Less than RBC
Trichloroethylene	0.0028 - 0.0028	1/9	0.027	0.0042	NC	NA	58	NA	NO	' Less than RBC

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TABLE 9-16 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SEDIMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

机学校的和科学学校的科学学校的教育		Frequency	Maximum	42963		Upgradient					
	Range of	lo	Detected	Arithmetic	95%	Sediment	Region III				
	SQLs	Detection	Concentration	Mean	UCL	Concentration *	RBC ***	ARARS ****	CPC?	NOTES	
Trichlorofluoromethane	0.0059 - 0.0059	2/9	0.076	0.013	NC	NA	2300	NA	NO	¹ Less than RBC	
TPH BY GC											
Diesel Fuel	8-8	5/6	170	78	NC	46	NA	• • NA	YES	No Standard	1
Total Petroleum Hydrocarbons, Gas Fraction	8 - 8	3/6	150	64	NC	57	NA	ŇA	YES	No Standard	
				-							
OTHER											
Total Petroleum Hydrocarbons (418.1)	28-28	7/9	3,200	790	NĊ	240	NA	NA	YES	No Standard	
Total Petroleum Hydrocarbons (IR)	-1800-31000	1/3 -	2,500	6,300	NC	NA	NA	NA	YES	'No Standard	

Notes:

Based un samples from 57D-95-04X through 57D-95-07X, 57D-95-07X, 57D-95-10X, and 57D-98-01X through 57D-98-03X.
USEPA soil tend screening level (OSWER Directive 9355.4-12, 1994b)
⁶ The value for naphthalene used as a surrugate
¹⁰ The value for naphthalene used as a surrugate
¹⁰ The value for naphthalene used as a surrugate
¹⁰ The value for naphthalene used as a surrugate
¹⁰ The value for naphthalene used as a surrugate
¹⁰ The value for naphthalene used as a surrugate
¹⁰ The value for naphthalene used as a surrugate
¹¹ The value for naphthalene used as a surrugate
¹¹ The value for naphthalene used as a surrugate
¹² The value for naphthalene used as a surrugate
¹² The value for naphthalene used as a surrugate
¹² The value for naphthalene used as a surrugate
¹² The value for naphthalene used as a surrugate
¹² The value for naphthalene used as a surrugate
¹³ The value for naphthalene used as a surrugate
¹⁴ The value for naphthalene used as a surrugate
¹⁴ The value for naphthalene used as a surrugate
¹⁴ The value for surrugate (Classical Will a LIO⁶ cancer risk level;
¹⁴ RBCs based on nonearcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).
¹⁴ ARARs are primary or secondary MCLs.

Less than RBC - Maximum detected concentration is less than risk-based concentration

² Background - Sample concentrations detected are at or below background concentrations.

³ Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

⁴ Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

⁵ Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

* Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

⁷ No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration

mg - milligram kg - kilogram SQL - Sample Quantitation Limit NA - No value available ND - Not calculated because there are fewer than 10 samples. - Not applicable PAL - project analyte list UCL - upper confidence limit ARARs - Applicable or Relevant and Appropriate Requirements CPC - Contamination foroneum

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TABLE 9-17 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SEDIMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

and the second second second second	all second all and	Frequency	Maximum		and the second	Upgradient				
STATE OF THE PROPERTY OF THE P	Range of	of	Detected	Arithmetic	95%	Sediment	Region III			
	SQLs	Detection	Concentration	Mean	UCL	Concentration *	RBC ***	ARARS ****	CPC?	NOTES
SEDIMENT (mg/kg) "										
PAL METALS										
Arsenic	CARDE DE ADROCT	5/5	37	20	NC	110	0.43	· NA ···	YES	Exceeds RBC, Background
Barium		5/5	60	33	NC	101	550	NA	NO	Less than RBC, ² Background
Соррег	0.97 - 0.97	3/5	11	4	NC	31	310	NA	NO	'Less than RBC, ' Background
Lead	10.5 - 10.5	2/5	65	23	NC	208	NA	400 "	NO	³ Less than ARAR, ² Background
Manganese Managanese Contractor	(Non-Braine) and the	- 5/5	459	188	NC	1,510	160	NA	YES	Exceeds RBC, * Background
Selenium	2.42 - 2.42	1/5	9.0	2.8	NC	2.8	39	NA	NO	Less than RBC
Zinc	8.03 - 8.03	1/5	91	21	NC	315	2300	NA	NO	Less than RBC, - Background
PESTICIDES/PCBs		. –								
4,4'-DDD	0.0083 - 0.0083	3/5	0.15	0.053	NC	0.53	2.7	NA	NO	Less than RBC, - Background
Aroclor-1260	0.08 - 0.08	1/5	- 1	0.20	NC	NA	0,32	NA	· YES	*Exceeds RBC
PAL SEMIVOLATILE ORGANICS										11
1,2-Dichlorobenzene	0.11 - 0.11	1/5	0.39	0.12	NC	NA	700	NA	NO	Less than RBC
1,4-Dichlorobenzene	0.098 - 0.098	2/5	1	0.32	NC	NA	27	NA	NO	Less than RBC
Benzo[b]fluoranthene	0.21 - 0.21	1/5	0.49	0.18	NC	NA	0.87	NA	NO	Less than RBC
Benzo[k]fluoranthene	0.066 - 0.066	3/5	0.28	0.15	NC	1.8	8.7	NA	NO	Less than RBC
Chrysene	0.12 - 0.12	1/5	0.34	0.12	NC	NA	87	NA	NO	Less than RBC
Fluoranthene	0.068 - 0.068	4/5	0.65	0.36	NC	5.0	310	NA	NO	Less than RBC
Naphthalene	0.037 - 0.037	2/5	0.53	0.14	NC	NA	160	NA	NO	Less than RBC
Phenanthrene	0.033 - 0.033	4/5	0.37	0.19	NC	2.3	160 ~	NA	NO	Less than KBC
Ругене		5/5	0.56	0.36	NC	4.8	230	NA	NO	Less than RBC
PAL VOLATILE ORGANICS (µg/g)										Li ti BBO
Acetone		5/5	0.21	0.15	NC	0.55	780	<u>NA</u>	NO	Less than RBC
Benzene	0.0015 - 0.0015	2/5	0.037	0.0093	NC	NA	22	NA	NO	Less than RBC
Chlorobenzene	0.0009 - 0.0009	3/5	0.019	0.0072	NC	NA	160	NA	NO	Less than RBC
Toluene	0,0008 - 0.0008	3/5	0.0048	0.0024	NC	NA	1600	NA	NO	Less man RBC
Xylenes	0.0015 - 0.0015	1/5	0.011	0.0028	NC	NA	16,000	NA	NO	Less man KBC
OTHER			and a successful Annual Ann	and out that was a new prophytematic	for survey and the survey of the	water a gauge of the contract of the second second second				
Total Petroleum Hydrocarbous	NA	5/5	3,500	850	NC	238	NA	NA	YES	No Standard
EPH Fractions			et a constitute d'alterna de la constitute	and a serie of the opposite of the state of the second	weeks and a second	and the second	NUMBER OF STREET			NIC Standard
C11-C22-Aromatics	50 - 160	1/5	280	90	NC	NA	NA	NA ····	YES	No Standard
C19-C36 Alighatics	50 - 160	1/5	630	160	NC	. NA	NA NA	NA,	YES (no Standaro

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TABLE 9-17 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SEDIMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Maximum	Upgradient			the second second
The second s	Range of of	Detected Arithm	ctic 95% Sediment	Region III		
	SQLs Detection	Concentration Mean	UCL Concentration *	RBC *** ARARS ****	CPC?	NOTES
VPH Fractions						
C5-C8 Aliphatics	1.8 - 8 1/5	3.3 2.1	NC . NA	NA NA	YES No Standard	l, second second
C9-C10 Aromatics	1.8 - 8 1/5	4.3 - 2.3	NG NA	NA NA	YES No Standard	1
C9-C10 Aliphatics	1.8 - 8 2/5	5.6 3.2	NC NA	NA NA	YES No Standard	terrendet ander Donalers

Notes:

- * Based on samples 57D-98-04X through 57D-98-08X.
- ⁴ USEPA soil lead screening level (OSWER Directive 9355.4-12, 1994b)
- " The value for naphthalene used as a surrogate
- * The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only).

Upgradient sample locations include 57D-95-03X and -08X.

- *** Region III RBCs (USEPA, 1999): Residential RBC for soil used for sediment evaluation.
- RBCs based on carcinogenic effects are associated with a 1x10⁴ cancer tisk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

**** ARARs are primary or secondary MCLs.

Less than RBC - Maximum detected concentration is less than risk-based concentration

² Background - Sample concentrations detected are at or below background concentrations.

- ³ Exceeds RBC Maximum detected concentration exceeds risk-based concentration
- ⁴ Essential Nutrient Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.
- ⁴ Less than ARARs Maximum detected concentration is less than concentration shown in ARARs column.
- ⁶ Exceeds ARARs Maximum detected concentration is greater than concentration shown in ARARs column.

¹ No standard available - No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. RBC - Risk-based concentration mg - milligram SQL - Sample Quanitation Limit NA - No value available ND - Not detected NC - Not calculated because there are fewer than 10 samples. - Not applicable PAL - project analyte list UCL - upper confidence limit ARARs - Applicable or Relevant and Appropriate Requirements CPC - Contaminant of concern
TABLE 9-18 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SURFACE WATER

	Frequency	Maximum			Upgradient	1.1	- 1 A T		
Range of	of	Detected	Arithmetic	95%	Surface Water	Region III	5 S. H.		
SOLs	Detection	Concentration	Мевп	UCL	Concentration *	RBC **	ARARS ***	CPC?	NOTES
SURFACE WATER - UNFILTERED (ug/L) *									
									······································
PAL METALS							white the second s		
Aluminum 141-141	5/6	15,100	2,650	NC	- ND	3700	NA	YES	Exceeds RBC
Arsenic	9/9	198	ું 51 - 🔅	NC	5.4	0.045	NA	YES	Exceeds RBC
Bartum	9/9	553	155	NC .	12.6	260	NA	YES	Exceeds RBC
Cadmium 4.0 - 4.0	1/6	25	5.8	NC	ND	1.8	- NA	YES	Exceeds RBC
Calcium	6/6	28,700	23,350	NC	24,300	NA	NA	NO	* Essential Nutrient
Chromium 6.0 - 6.0 -	1/6	36	8.5	NC	ND	11	NA	YES	Exceeds RBC
Copper 8.1 - 8.1	4/9	- 375	74.9	NĊ	9	150	NA.	YES	Exceeds RBC.
Iron	6/6	17,600	5840	NC	- 645	1100	NA	YES	Exceeds RBC
Lead 1.3 - 1.3	7/9	967	243	NC	ND	NA	15 *	YES	Exceeds ARARs
Magnesium	6/6	4930	3307	NC	3630	NA	NA	NO	* Essential Nutrient
Manganese	6/6	433	243	NC	131	73	NA	YES -	Exceeds RBC
Mcrcury 0.24 - 0.24	1/6	0.24	0.14	NC	ND	1.1	NA	NO	'Less than RBC
Potassium	6/6	3,840	1,887	NC	1,630	NA	NA	NO	* Essential Nutrient
Selenium 2 - 3.02	1/9	2.4	1.5	NC	ND	18	NA	NO	Less than RBC
Sodium	6/6	60,900	26,250	NC	19,200	NA	NA	NO	* Essential Nutrient
Vanadium 11-11	1/6	72	17	NC	ND ,	26 :	NA	YES	Exceeds RBC
Zinc 21.1-21.1	5/9	712	180	NC	ND	1100	NA	NO	Less than RBC
PAL SEMIVOLATILE ORGANICS						www.mashw.com/v.lon/994464	01000 071000 NOV U ~ ~ 723 0100 (VID	weather and the state	
Bis(2-ethylbexyl)phthalate 4.8 - 4.8	1/9	24	4.8	NC	NA.	4.8	NA	YES	Exceeds RBC
Phenanthrene 0.5 - 0.5	1/9	0.52	0.28	NC	NA	6.5	NA	NO	*Less than RBC
NAL VOL 1777 P.ODCANICS									
PAL VOLATILE ORGANICS	1 KO (111)	26	2 1	NC	ND	55	NA	YES	⁴ Exceeds RBC
1,2-Dicinoroeutytelles (totat)	1/0	11	0.34	NC	NĤ	100	NA	NO	Less than RBC
	10.	0.72	0.34	NC	ND	0.15	NA	YES	*Exceeds RBC
Chloroterin 0.3-0.3	2/9	4 I	1.8	NC	3	41	NA	NO	Less than RBC
Memylene chloride 2.3 - 2.3	3/7	4.1	1.0 	NC	ND	11	NA	YES	Exceeds RBC
Tetrachioroeutyjene 7.6-1.0	1/0	2.0	0.34	NC	0.42	75	NA	NO	¹ Less than RBC
1010Elle 0.3 - 0.5	20	•••	0.45	 NC	NI)	16	NA	VES	Exceeds RBC.

TABLE 9-18 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 2 RECREATIONAL USE SURFACE WATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		Frequency	Maximum			Upgradient			-11. T 4. T	
	Range of	of	Detected	Arithmetic	95%	Surface Water	Region III	11-11-11-11-11-11-11-11-11-11-11-11-11-	e di Atari	
	SQLs	Detection	Concentration	Mean	UCL	Concentration *	RBC **	ARARS ***	CPC?	NOTES
OTHER										·····
Total Petroleum Hydrocarbons	168 - 176	2/6	924	252	NC	NA	NA 2	NA	YES	No Standard ++
EPH Fractions										
C11-C22 Aromatics		3/3	1,400	797	NC	NA	NA	NA NA	YES	No Standard
C19-C36 Aliphatics		- 3/3	1,700	1,280	NC	NA	NA	· NA 👘	YES	No Standard
					-					·····
SURFACE WATER - FILTERED) (ug/L) *									
PAL METALS						All water and any construction of the second states and the second states and the second states and the second	A 19 Mar Well Prove & married Automatics (19 Married	Wheelers No. 7		
Arsenic	2:5 - 2,5	4/5	9	4	NC .	4.4	0,045	NA	YES	Exceeds RBC
Barium		5/5	43	22	NC	12	260	NA	NO	Less than RBC
Calcium		4/4	24,000	19,300	NC	24,100	NA	NA	NO	² Essential Nutrient, ² Background
Iron		4/4	17,200	4,540	NC NC	254	1100	NA	YES	Exceeds RBC
Lead	1.3 - 50	1/5	2	6	NC	NA	NA	15 °	NO	² Less than ARAR
Magnesium		4/4	3,550	2,260	NC	3,610	NA	NA	NO	⁴ Essential Nutrient, ² Background
Manganese	ten and a second	• 4/4	483	197	NC NC	107	73	NĄ	YES	*Exceeds RBC
Potassium		4/4	2,430	1,850	NC	1,700	NA	NA	NO	Essential Nutrient
Sodium		4/4	56,900	27,800	NC	19,000	NA	NA	NO	Essential Nutrient
Zinc	21.1 - 35.8	1/5	58	22	NC	NA	1100	NA	NO	Less than RBC

Notes:

*Sample locations include: 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57W-98-01X through 57W-98-03X.

^b Filtered samples were collected at 57W-95-D4X

⁶ Massachusetts Drinking Water Standard (MADEP, 1998).

^d The value for naphthalene used as a surrogate

* The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only).

Upgradient sample locations include \$7D-95-03X and -08X.

** Region III RBCs (USEPA, 1999): Tap Water RBCs used for surface water evaluation.

RBCs based on carcinogenic effects are associated with a 1x10⁴ cancer risk level;

RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).

*** ARARs are primary or secondary MCLs.

Less than RBC - Maximum detected concentration is less than risk-based concentration

² Background - Sample concentrations detected are at or below background concentrations.

³ Exceeds RBC - Maximum detected concentration exceeds risk-based concentration

⁴ Essential Nutrient - Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.

⁵ Less than ARARs - Maximum detected concentration is less than concentration shown in ARARs column.

" Exceeds ARARs - Maximum detected concentration is greater than concentration shown in ARARs column.

⁷ No standard available - No RBC or ARARs available, therefore analyte is a CPC.

4/14/00 10:02 AM

Chemicals selected as CPCs are shaded.

NC - Not calculated because there are fewer than 10 samples.

ARARs - Applicable or Relevant and Appropriate Requirements

RBC - Risk-based concentration

SQL - Sample Quantitation Limit

NA - No value available

PAL - project analyte list

UCL - apper confidence limit

CPC - Contaminant of concern

ug - microgram

ND - Not detected

- Not applicable

L - liter

TABLE 9-19 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SURFACE WATER

		Frequency	Maximum			Upgradient					
· contraction of the second	Range of	of	Detected	Arithmetic	95%	Surface Water	Region III				
	SQLs	Detection	Concentration	Mean ···	UCL	Concentration *	RBC **	ARARS ***	CPC?	NOT	ES
SURFACE WATER - UNFILTERED (ug/	'L) "										
PAL METALS			Constraint Company of the International State (1996) (1997) (1997)	and unitation as a such with the	na atawa na amin'ny tsisten diasima tau	-Advision and a state of the second	en an anna an tao an		where the second second	PDC	
Antimony	+1-1	3/5	5,6	2.1	NC	NA	1.5	NA	YES	Exceeds RBC	
Arsenic		4/4	153	~ <u>49</u>	NC	-5.4	0.045	NA	YES	Exceeds ABC	
Barium		5/5	278	176	NC	13	~ 260	NA.	YES	Lander BDC	
Copper	5 - 5	4/5	44	24	NC	9,0	150	NA	NO	Less man RBC	
Lead		5/5	184	92	NC	NA	NA	C1	YES	Exceeds ARAR	
Manganese		. <u>1</u> /1	93	.93.0	* NC	131		NA	· YES	Exceeds RBU, Backgro	NIDO, 7
Selenium	2 - 2	2/5	2.5	1.5	NC	NA	18	NA	NO	Less than RBC	
Zinc	36 - 36	4/5	445	211	NC	NA	1100	NA	NO	Less than KBC	
PAL SEMIVOLATILE ORGANICS			an mana di canana nacio in stato desir basto considere de deservoltare	Concerning of the All Street and	THE REAL PROPERTY OF A DESCRIPTION		ALC: NOT OF STREET, STREET, ST	to a company of the second second	STATISTICS AND	Dissonder D DAT	
Benzo[k]fluoranthene	0.87 - 0.87	1/4	0.94		NC	NA	0.92	NA	3 ES	EXCEES ADC	And Andrews Street
							<u> </u>	· · · · ·			
PAL VOLATILE ORGANICS		172	0.69	0.77	NC	NA	100	NA	NO	Less than RBC	
Carbon Disulfide	0.5 - 0.5	1/5	0.56	0.32	NC	NA	100	NA	NO	Less than RBC	
Chlorobenzene	0.5 0.5	2/5	4.0	0.59	NC	NA	75	NA	NO	Less than RBC	
loluene	0.3 - 0.5		1.0								
OTHER				· • • • • • • • • • • • • • • • • • • •							
EPH Eractions											
C11_C22 Aromatics		5/5	650	430	NC	NA	NA	NA	YES	No Standard	
C19 C36 Alighetics	500 - 530	2/5	1100	570	NC	NA	NA	NA	YES	No Standard	
VDU Emotions		az met za odkada	AND THE REAL PROPERTY OF THE REAL PROPERTY OF A DESCRIPTION	COLOGARY & C.N. 890(1723	· · · · · · · · · · · · · · · · · · ·	N. N	and the second				
	20	1/5	25	13	NC	ŇÁ	NA	NA	YES	No Standard	
Posto to monimues		and the second		and the second	ar an	NAME OF A DESCRIPTION OF A			a contract of the state of the state		

TABLE 9-19 CHEMICALS OF POTENTIAL CONCERN AOC 57 AREA 3 RECREATIONAL USE SURFACE WATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Maximum	1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -		Upgradient						Sec
	Range of of	Detected	Arithmetic	95%	Surface Water	Region III		1. 19 gr		- 10 C	
A second second second second second second	SQLs Detection	Concentration	Mean	UCL	Concentration *	RBC **	ARARS ***	CPC?	ala di seri da seri	NOTES	
SURFACE WATER - FILTERED (ug/L)		· · · · · · · · · · · · · · · · · · ·									
				-							
PAL METALS											
Arsenic		. 53	20 +	NC	4.4	0.045	NA	YES	² Exceeds RBC		
Barium	5/5	23	13	NC	12	260	NA	NO	Less than RBC		
Manganeso	2/2	155	- 96	NC	107	73	NA	YES	"Exceeds RBC		11 St 2

Notes:

- * Sample locations include: 57W-98-04X through 57W-98-08X (duplicate at 57W-98-07X).
- ^b Filtered samples were collected at 57W-98-04X through 57W-98-08X.
- * Massachusetts Drinking Water Standard (MADEP, 1998).
- * The arithmetic mean of concentrations detected in upgradient samples was used for background (inorganics only).
- Upgradient sample locations include 57W-95-03X and -08X.
- ** Region III RECs (USEPA, 1999): Tap water RBCs used for surface water evaluation.
- RBCs based on earchnogenic effects are associated with a 1x10 "cancer risk level;
- RBCs based on noncarcinogenic effects are adjusted for a target HQ of 0.1 (USEPA, 1999).
- *** ARARs are primary or secondary MCLs.

1 Less than RBC - Maximum detected concentration is less than risk-fused concentration

- ² Background Sample concentrations detected are at or below background concentrations.
- ¹ Exceeds RBC Maximum detected concentration exceeds risk-based concentration
- * Essential Nutrient Analyte is an essential human nutrient (magnesium, calcium, potassium, sodium) and is not considered a CPC.
- ⁵ Less than ARARs Maximum detected concentration is less than concentration shown in ARARs column.
- * Exceeds ARARs Maximum detected concentration is greater than concentration shown in ARARs column.
- ³ No standard available No RBC or ARARs available, therefore analyte is a CPC.

Chemicals selected as CPCs are shaded. REC - Risk-based concentration ug - micrograms L - Liter SQL - Sample Quantitation Limit NA - No value available ND - Not detected NC - Not calculated because there are fewer than 10 samples. — Not applicable PAL - project analyte fist UCL - upper conface limit ARARs - Applicable or Relevant and Appropriate Requirements CPC - Construinant of concern STATISTICS WALFAR STATISTICS.

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASONFOR SELECTION OR EXCLUSION
AREA 2 INDUSTRIAL			
Current/Future Land Use			
Maintenance Worker	Incidental ingestion of surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via ingestion.
	Dermal contact with surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dermal contact.
	Inhalation of particulates from surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dust inhalation.
	Inhalation of VOCs from surface soil	No	No VOCs were selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers are unlikely to come in contact with groundwater.
	inhalation of VOCs from groundwater	No	Workers are unlikely to come in contact with groundwater and migration of vapors to ambient air is not considered a significant source of exposure (a).
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Ycs	Excavation may expose future workers to contaminated soils via dermal contact.
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation work is likely to generate dust.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs were selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers would probably wear protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air is not considered a significant source of exposure (a)
Commercial Worker	Incidental ingestion of surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas via ingestion.
	Dermal contact with surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas via dermal contact.
	Inbalation of particulates from surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas via dust inhalation.
Commercial Worker	Ingestion of drinking water	Yes	Groundwater is considered a possible source of potable water at the site.
	Inhalation of VOCs volatilizing from shallow groundwater or volatilizing from process water.	No	Volatiles could migrate to indoor air or be released from industrial process water, however maximum detected VOCs in groundwater are below the MCP GW-2 Standards.

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.
AREA 2 - RECREATIO	NAL		
Current/Future Land Use			
Recreational Child	Incidental ingestion of surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in these media via ingestion.
	Dermal contact with surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in soil via dermal contact.
	Inhalation of particulates from surface soil	No	Considered insignificant due to saturated soils.
	Inhalation of VOCs from surface soil	No	No VOCs selected as CPCs.
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via dermal contact.
	Inhalation of particulates from surface and subsurface soil	Ycs	Excavation work is likely to generate dust.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs were selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers would probably wear protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air is not considered a significant source of exposure (a)

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND FOINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.
AREA 3 - INDUSTRIAI	2		
Current/Future Land Use			
Maintenance Worker	Incidental ingestion of surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via ingestion.
	Dermal contact with surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dermal contact.
	Inhalation of particulates from surface soil	Yes	Performing routine work could expose workers to contaminated surface soil via dust inhalation.
	Inhalation of VOCs from surface soil	No	No VOCs selected as CPCs.
	Incidental ingestion and dermal contact with groundwater	No	Workers are unlikely to come in contact with groundwater.
	Inhalation of VOCs from groundwater	No	Workers are unlikely to come in contact with groundwater and migration of vapors to ambient air is not considered a significant source of exposure.
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dermal contact
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dust inhalation.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs selected as CPCs .
	Incidental ingestion and dermal contact with groundwater	No	Workers would be wearing protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Commercial Worker	Incidental ingestion of surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas soils via ingestion.
	Dermal contact with surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Future workers may be exposed to contaminated soils in unpaved areas soils via dust inhalation.
	Ingestion of drinking water	Yes	Groundwater is considered a possible source of potable water at the site.
	Inhalation of VOCs volatilizing from shallow groundwater or volatilizing from process water.	No	Volatiles could migrate to indoor air or be released from industrial process water, however maximum detected VOCs in groundwater are below the MCP GW-2 Standards.
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.
AREA 3 - RECREATIO	NAL		
Current/Future Land Use			
Recreational Child	Incidental ingestion of surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in surface soil via ingestion.
	Dermal contact with surface soil, sediment and surface water	Yes	Children playing in the recreational area may be exposed to contaminants in soil via dermal contact.
	Inhalation of particulates from surface soil	No	Considered insignificant due to saturated soils.
	inhalation of VOCs from surface soil	No	No VOCs selected as CPCs.

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

POTENTIALLY EXPOSED POPULATION	EXPOSURE ROUTE, MEDIUM, AND POINT	EVALUATED?	REASON FOR SELECTION OR EXCLUSION
Possible Future Land Use			
Construction Worker	Incidental ingestion of surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soils via ingestion.
	Dermal contact with surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dermal contact
	Inhalation of particulates from surface and subsurface soil	Yes	Excavation may expose future workers to contaminated soil through dust inhalation.
	Inhalation of VOCs from surface and subsurface soil	No	No VOCs selected as CPCs .
	Incidental ingestion and dermal contact with groundwater	No	Workers would be wearing protective clothing, which would mitigate exposure from these routes.
	Inhalation of VOCs from groundwater	No	Migration of vapors to ambient air not considered a significant source of exposure (a).
Unrestricted Future Land Use			
Adult and Child Resident	Incidental ingestion of surface soil	Yes	Residents may be exposed to contaminated soils via ingestion.
	Dermal contact with surface soil	Yes	Residents may be exposed to contaminated soils via dermal contact.
	Inhalation of particulates from surface soil	Yes	Residents may be exposed to contaminated soils via dust inhalation.
	Inhalation of VOCs from groundwater	No	Migration of vapore to ambient air not considered a significant source of exposure (a).
	Ingestion of groundwater	Yes	Although groundwater is not considered a source of potable water at the site, consumption of groundwater is assessed to evaluate risk management obligations for unrestricted land use.

Notes:

VOC - Volatile Organic Compound CPC - Chemical of Potential Concern

GW - Groundwater
 (a) Maximum concentrations of VOCs in groundwater do not exceed the MCP GW-2 Standard.

MADEP - Massachusetts Department of Environmental Protection MCP - Massachusetts Contingency Plan

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TABLE 9-21 COMPARISON OF GW-2 STANDARDS TO VOLATILE CPCs AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		Maximum		
		Detected		Maximum Exceed
Site Area	Analyte	Concentration (ug/L)	GW-2 Standard (ug/L) ¹	GW-2 Standard?
Area 2 - Industrial	NA			
Area 2 - Recreational	Bis(2-ethylhexyl)phthalate	400	50,000	No
	1,2-Dichloroethylene (Total)	13	20,000	No
	Tetrachloroethylene	16	3000	No
	Trichloroethylene	1.9	300	No
Area 3 - Industrial	1,2-Dichlorobenzene	9.8	10,000	No
	1,4-Dichlorobenzene	5.6	30,000	No
	Naphthalene	20	6000	No
- ··· -	Carbon Tetrachloride	4.5	20	No
	Chloroform	10	400	No
······································	Tetrachloroethylene	2.6	3000	No
Area 3 - Recreational	1,4-Dichlorobenzene	2.7	30,000	No
	Bis(2-ethylhexyl)phthalate	52	50,000	No
,, _,, _	Naphthalene	13	6000	No
	Tetrachloroethylene	5.5	3000	No
	Trichloroethylene	3.8	300	No

NOTES:

NA - Not applicable because there were no volatile CPCs selected therefore no GW-2 comparison.

¹ GW-2 Standard is from MADEP (310 CMR 40.097), October, 1997.

CPC - chemicals of concern

ug/L - micrograms per liter

TABLE 9-22 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 2 INDUSTRIAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Service restances and the service states	Frequency	Concent			
通信心理想在多少的问题的问题的。 第二章	lo l	Maximum	95%		
	Detection	Detected	UCL 7	EPC *	
SURFACE SOIL (0 - 2 feet bgs) (mg/kg)					
PAL METALS					
Arsenic	5 / 5	21	NC	21	
Chromium	5 / 5	27	NC	27	
Iron	5 / 5	16,400	NC	16,400	
Manganese	5 / 5	481	NC	481	
OTHER					
VPH Ranges [*]					
C9-C12 Aliphatics	5/5	32	NC	32	
C9-C10 Aromatics	5 / 5	23	NC	23	
EPH Ranges ^e		······			
C9-C18 Aliphatics	5/5	465	NC	465	
C19-C36 Aliphatics	5/5	5680	NC	5680	
C11-C22 Aromatics	5/5	1770	NC	1770	

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

" The EPC is the lesser of the 95% UCL and the maximum concentration.

* See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligram

Kg - kilogram

bgs - below ground surface

NC - Not calculated because there are fewer than 10 samples.

PAL - project analyte list

UCL - upper confidence limit

EPC exposure point concentration

.

TABLE 9-23 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 2 INDUSTRIAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

the second s	Frequency	Conce	Concentration		
	of Detection	Maximum Detected	95% UCL*	EPC*	
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)					
PAL METALS	······				
Arsenic	4 / 4	9.87	NC	9.87	
Iron	4 / 4	8080	NC	8080	
Manganese	4 / 4	231	NC	231	
OTHER		······································			
VPH RANGES*					
C9-C12 Aliphatics	4 / 4	0.57	NC	0.57	
C9-C10 Aromatics	4 / 4	0.41	NC	0.41	
EPH RANGES ·					
C9-C18 Aliphatics	4 / 4	8.2	NC	8.2	
C19-C36 Aliphatics	4 / 4	101	NC	101	
C11-C22 Aromatics	4 / 4	31	NC	31	

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the lesser of the 95% UCL and the maximum concentration.

⁶ See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligram

kg - kilogram

bgs - below ground surface

NC - Not calculated because there are fewer than 10 samples."

PAL - project analyte list

UCL - upper confidence limit

EPC exposure point concentration

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TABLE 9-24 EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AOC 57 AREA 2 INDUSTRIAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

and the second second second second second second second	Frequency	Concen	Concentration	
	of	Maximum	95%	
	Detection	Detected	UCL."	EPC °
			±	
GROUNDWATER - UNFILTERED (µg/L)				
PAL METALS			· · · · · · · · · · · · · · · · · · ·	
Aluminum	1 / 2	204	NA	204
Manganese	2 / 2	177	NA	177
GROUNDWATER - FILTERED (µg/L)				
PAL METALS				
Aluminum	1 / 2	167	NA	167
Manganese	2 / 2	173	NA	173
· · · · · · · · · · · · · · · · · · ·		-		

NOTES:

The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the maximum concentration.

µg - micrograms

L - liter NA - 95% UCL not applicable to groundwater

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-25 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 2 RECREATIONAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Concent	ration		
	of .	Maximum	95%		
	Detection	Detected	UCD	EPC.	
SURFACE SOIL (0 - 2 fect bgs) (mg/kg)					
PAL METALS					
Arsenic	11 / 11	61.2	47.9	47.9	
Iron	3 / 3	7920	NC	7920	
Manganese	11 / 11	679	273	273	
PESTICIDES/PCBs					
Aroclor-1260	8 / 11	4.2	3.6	3.6	
OTHER					
VPH Ranges					
C9-C12 Aliphatics	11 / 11	21	29	21	
C9-C10 Aromatics	11 / 11	17	24	17	
EPH Ranges ^e					
C9-C18 Aliphatics	11 / 11	298	343	298	
C19-C36 Aliphatics	11 / 11	3640	5760	3640	
C11-C22 Aromatics	11 / 11	1130	1360	1130	

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the lesser of the maximum concentration and the 95% UCL.

" See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams Kg - kilogram bgs - below ground surface NC - Not calculated because there are fewer than 10 samples. PAL - project analyte list UCL - upper confidence limit

TABLE 9-26 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 2 RECREATIONAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

and a second	Frequency	Concen	tration	entropy of the feedback
	of	Maximum	95%	
	Detection	Detected	UCL*	EPC ^b
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)				
PAL METALS	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	*·····	
Aluminum	10 / 10	9940	6970	6970
Arsenic	10 / 10	21	24	21
Chromium	5 / 10	2410	8350	2410
Iron	10 / 10	6880	9900	6880
Lead	12 / 12	5060	30,600	5060
Manganese	12 / 12	175	169	169
PESTICIDES/PCBS				
Dieldrin	2 / 12	0.043	0.0113	0.0113
Aroclor - 1248	1 / 12	3.2	0.482	0.482
Aroclor - 1260	4 / 12	12	156	12
OTHER				
VPH Ranges				
C9-C12 Aliphatics ⁴	12 / 12	130	33,200	130
C9-C10 Aromatics ^a	10 / 12	93	22,200	93
EPH Ranges				· · · · · · · · · · · · · · · · · · ·
C9-C18 Aliphatics	11 / 12	1860	625,000	1860
C19-C36 Aliphatics	12 / 12	22,700	12,200,000	22,700
C11-C22 Aromatics ⁴	12 / 12	7050	3,510,000	7050

NOTES:

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* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

" The EPC is the lesser of the maximum concentration and the 95% UCL.

" See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams Kg - kilogram bgs - below ground surface NC - Not calculated because there are fewer than 10 samples. PAL - project analyte list UCL - upper confidence limit

TABLE 9-27 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 2 RECREATIONAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	ration	en al service de la companya de la c	
	of	Maximum	95%	
	Detection	Detected	UCL*	EPC *
GROUNDWATER - UNFILTERED (µg/L) ¹				
PAL METALS			·	
Areanic	2 / 6	54.4	NA	54.4
Iron	2/5	3610	NA	3610
Manganese	5 / 5	724	NA	724
PESTICIDES/PCBs				
Aroclor-1260	1 / 6	0.22	NA	0.22
PAL SEMIVOLATILE ORGANICS				······································
Bis(2-ethylhexyl)phthalate	3 / 6	400	NA	400
PAL VOLATILE ORGANICS				
1,2-dichloroethylene (total)	2 / 6	13	NA	13
Tetrachloroethylene	2 / 6	16	NA	16
Trichloroethylene	3 / 6	1.9	NA	1.9
GROUNDWATER - FILTERED (µg/L)				
PAL METALS				
Arsenic	2 / 6	73	NA	73
Iron	2 / 5	3530	NA	3530
Manganese	5 / 5	819	NA	819

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

" The EPC is the maximum concentration.

µg - micrograms

L - liter

NA - 95% UCL not applicable to groundwater

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-28 EXPOSURE POINT CONCENTRATIONS IN SEDIMENT AOC 57 AREA 2 RECREATIONAL USE SEDIMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Maximum		
	of	Detected	95%	
如何有些"你们的",我们就是是我们的"你们的"。	Detection	Concentration	UCL*	EPC °
SEDIMENT (mg/kg)				
PAL METALS				
Aluminum	6/6	15,900	NC	15,900
Arsenic	9/9	220	NC	220
Chromium	3/6	49	NC	49
Iron	6/6	30,400	NC	30,400
Lead	8/9	410	NC	410
Manganese	9/9	3,940	NC	3,940
PESTICIDES/PCBs				
Dieldrín	2/9	0.046	NC	0.046
OTHER				·····
Total Petroleum Hydrocarbons	7/9	3200 °	NC	3,200

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

^b The EPC is the lesser of the maximum concentration and the 95% UCL.

⁶ Maximum detected values among all TPH analytical methods.

- mg milligrams
- Kg kilogram

bgs - below ground surface

NC - Not calculated because there are fewer than 10 samples.

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-29 EXPOSURE POINT CONCENTRATIONS IN SURFACE WATER AOC 57 AREA 2 RECREATIONAL USE SURFACE WATER

	Frequency	Maximum	and the second second	Sector States States
中国为国际储存的资产运行 网络福尔马克伦尔马克	of	Detected	95%	
	Detection	Concentration	UCL *	EPC °
SURFACE WATER - UNFILTERED (ug/L)				
PAL METALS				
Aluminum	5/6	15,100	NA	15,100
Arsenic	9/9	198	NA	198
Barium	9/9	553	NA	553
Cadmium	1/6	25	NA	25
Chromium	1/6	36	NA	36
Copper	4/9	375	NA	375
Iron	6/6	17,600	NA	17,600
Lead	7/9	967	NA	967
Manganese	6/6	433	NA	433
Vanadium	1/6	72	NA	72
PAL SEMIVOLATILE ORGANICS				
Bis(2-ethylhexyl)phthalate	1/9	24	NA	24
	,			
PAL VOLATILE ORGANICS				
1,2-Dichloroethylenes (total)	1/9	26	NA	26
Chloroform	1/9	0.72	NA	0.72
Tetrachloroethylene	2/9	2.6	NA	2.6
Trichloroethylene	2/9	3.5	NA	3.5
OTHER		nrossnann 🖬 M		
EPH Fractions				

TABLE 9-29 EXPOSURE POINT CONCENTRATIONS IN SURFACE WATER AOC 57 AREA 2 RECREATIONAL USE SURFACE WATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Maximum		
	lo	Detected	95%	
	Detection	Concentration	ŪCLª	EPC [*]
C11-C22 Aromatics	3/3	1,400	NA	1,400
C19-C36 Aliphatics	3/3	1,700	NA	1,700
SURFACE WATER - FILTERED (ug/L)		·····		· · · · · · · · · · · · · · · · · · ·
PAL METALS		······		
Arsenic	4/5	9	NA	9
Iron	4/4	17,200	NA	17,200
Manganese	4/4	483	NA	483

NOTES:

The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccuracy of the calculation for small data sets, UCLs are not calculated if the data set contains fewer than 10 samples.
 The EPC is the maximum detected concentration.

ug - micrograms

L ~ liter

NA - 95% UCL not applicable to surface water

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-30 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 3 INDUSTRIAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Concentration			
	of	Maximum	95%		
	Detection	Detected	UCL ' 🧠	EPC*	
SURFACE SOIL (0 - 2 feet bgs) (mg/kg) ⁴			·····		
PAL METALS					
Arsenic	2 / 2	41	NC	41	
Iron	2 / 2	8040	NC	8040	
Manganese	2 / 2	548	NC	548	
OTHER					
VPH Ranges'					
C9-C12 Aliphatics	3/6	16	NC	16	
C9-C10 Aromatics	3 / 6	4.85	NC	4.85	
EPH Ranges					
C9-C18 Aliphatics	2 / 6	3.63	NC	3.63	
C19-C36 Aliphatics	3/6	38	NC	38	
C11-C22 Aromatics	2 / 6	9.75	NC	9.75	

NOTES:

The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the lesser of the 95% UCL and the maximum concentration.

* See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams

kg - kilograms

NC - Not calculated because there are fewer than 10 samples.

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-31 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 3 INDUSTRIAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Concent	ration	
	of Detection	Maximum Detected	95% UCL '	ерс •
SUBSURFACE SOIL (2 - 15 feet bgs) (mg/kg)				
PAL METALS				······································
Arsenic	3 / 3	9.67	NC	9.67
Iron	3 / 3	6410	NC	6410
OTHER				
VPH Ranges				
C9-C12 Aliphatics	1/9	0.84	NC	0.84
C9-C10 Aromatics	1 / 9	0.35	NC	0.35
EPH Ranges	· · ·			
C9-C18 Aliphatics	3 / 9	78	NC	78
C19-C36 Aliphatics	6/9	990	NC	990
C11-C22 Aromatics	3 / 9	110	NC	110

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the lesser of the 95% UCL and the maximum concentration.

See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams kg - kilograms NC - Not calculated because there are fewer than 10 samples. PAL - project analyte list UCL - upper confidence limit EPC exposure point concentration

TABLE 9-32 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 3 INDUSTRIAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Concent	Concentration	
经保险 经保证管理 计算法 化合物合金 经公司	of	Maximum	95%	
	Detection	Detected	UCL*	EPC*
GROUNDWATER - UNFILTERED (µg/L)				
PAL METALS				
Aluminum	2/2	190	NA	190
Arsenic	1/2	33.2	NA	33.2
Cadmium	1/2	8.67	NA	8.67
Iron	2/2	12400	NA	12400
Manganese	2/2	466	NA	466
PAL SEMIVOLATILE ORGANICS				
1 2-Dichlorobenzene	1 / 2	9.8	NA	9.8
1 4-Dichlorobenzene	1 / 2	5.6	NA	5.6
Naphthalene	1 / 2	20	NA	20
PAL VOLATILE ORGANICS	1.4.5		214	4.5
Carbon Tetrachloride	1/2	4.5		4.5
Chloroform	1/2	10	NA	10
Tetrachloroethene	1 / 2	2.6	NA	2.6
OTHER			······	
C9-C10 Aromatics	1 / 1	310	NA	310
GROUNDWATER - FILTERED (µg/L)			·····	
PAL METALS				
Arsenic	1 / 1	40.1	NA	40.1
Iron	1 / 1	11300	NA	11300
Manganese	1 / 1	351	NA	351

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the maximum concentration.

µg - micrograms

L – liter

NA - 95% UCL not applicable to groundwater

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-33 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 3 RECREATIONAL USE SURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Concer	ntration	28 170 0.14
	10	Maximum	95%	
	Detection	Detected	UCL"	EPC*
SURFACE SOIL (0 - 2 feet bgs) (mg/kg	۳ (۱۹۹۵) ^۲ (۱۹۹۵)			
PALMETALS		20	<u></u>	20
Arsenic	272	28		20
Manganese	2 / 2	170	NC	170
PESTICIDES/PCBs			<u>,</u>	
Dieldrin	2 / 6	0.14	NC	0.14
· · ·	<u></u>	<u></u>		
OTHER				
VPH Ranges ^e				
C9-C12 Aliphatics"	4 / 6	1500	NC	1500
C9-C10 Aromatics ^a	3 / 6	600	NC	600
EPH Ranges ^e				<u></u>
C9-C18 Aliphatics	3 / 6	1300	NC	1300
C19-C36 Aliphatics [*]	5 / 6	20,000	NC	20,000
C11-C22 Aromatics*	5/6	3100	NC	3100

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the lesser of the maximum concentration and the 95% UCL.

* See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams

Kg - kilogram bgs - below ground surface NC - Not calculated because there are fewer than 10 samples. PAL - project analyte list UCL - upper confidence limit EPC exposure point concentration .



TABLE 9-34 EXPOSURE POINT CONCENTRATIONS AOC 57 AREA 3 RECREATIONAL USE SUBSURFACE SOIL

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

A MORE AND A CONTRACT OF A DECK OF A DECK	Frequency and	Concer	ntration	5.00 (B.S. 57 (77)
	lo - lo -	Maximum	95%	
	Detection	Detected	UCL · -	EPC*
UBSURFACE SOIL (2 - 15 feet bgs) (mg/kg	g) ²			
AT METALS	······································			
TAL MISTALS				

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

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* The EPC is the lesser of the maximum concentration and the 95% UCL.

* See Table @ for calculation of EPC for EPH/VPH fractions.

mg - milligrams

Kg - kilogram

bgs - below ground surface

NC - Not calculated because there are fewer than 10 samples.

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-35 EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AOC 57 AREA 3 RECREATIONAL USE GROUNDWATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

The second s	Frequency	Concent	han di dia bergi tara	
	of Detection	Maximum Detected	95% UCL *	EPC •
GROUNDWATER - UNFILTERED (µg/L)		······································		
PAL METALS				
Aluminum	3 / 3	2450	NA	2450
Arsenic	5/6	84.4	NA	84.4
Iron	3 / 3	1910	NA	1910
Manganese	3 / 3	346	NA	346
PAL SEMIVOLATILE ORGANICS				
1,4-Dichlorobenzene	1/6	2.7	NA	2.7
Bis(2-ethylhexyl)phthalate	2 / 6	52	NA	52
Naphthalene	2 / 6	13	NA	13
PAL VOLATILE ORGANICS				
Tetrachloroethene	1 / 6	5.5	NA	5.5
Trichloroethene	1/6	3.8	NA	3.8
OTHER		······································		
VPH Ranges				
C5-C8 Aliphatics	1 / 1	89.5	NA	89.5
C9-C12 Aliphatics	1 / 1	42.5	NA	42.5
C9-C10 Aromatics	1 / 1	172	NA	172
GROUNDWATER - FILTERED (µg/L)		· · ·		
PAL METALS				
Arsenic	3 / 3	138	NA	138

NOTES:

" The 95% UCL on the anthenetic mean is calculated assuming log-normal distribution of data. Because of the inaccruacy

of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

* The EPC is the maximum concentration.

µg - micrograms L. - liter

NA - 95% UCL not applicable to groundwater

PAL - project analyte list

UCL - upper confidence limit

TABLE 9-36 EXPOSURE POINT CONCENTRATIONS IN SEDIMENT AOC 57 AREA 3 RECREATIONAL USE SEDIMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

The second s	Frequency	Maximum		
	- of	Detected	95%	
	Detection	Concentration	UCL.*	EPC.º
			·····	
SEDIMENT (mg/kg)				
PAL METALS			· · · · · · · · · · · · · · · · · · ·	
Arsenic	5/5	37	NC	37
Manganese	5/5	459	NC	459
PESTICIDES/PCBs	· · · · · · · · · · · · · · · · · · ·			
Aroclor-1260	1/5	0.84	NC	0.84
EPH Fractions	·····			
C11-C22 Aromatics	1/5	280	NC	280
C19-C36 Aliphatics	1/5	630	NC	630
VPH Fractions				
C5-C8 Aliphatics	1/5	3.3	NC	3.3
C9-C10 Aromatics	1/5	4.3	NC	4.3
C9-C12 Aliphatics	2/5	5.6	NC	5.6

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccruaty of the calculation for small data sets, UCLS are not calculated if the data set contains fewer than 10 samples.

^b The EPC is the lesser of the maximum concentration and the 95% UCL.

mg - milligrams Kg - kilogram bgs - below ground surface NC - Not calculated because there are fewer than 10 samples. PAL - project analyte list

TABLE 9-37 EXPOSURE POINT CONCENTRATIONS IN SURFACE WATER AOC 57 AREA 3 RECREATIONAL USE SURFACE WATER

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Maximum		200 S 20 20 20 20 20 20 20 20 20 20 20 20 20
	of	Detected	95%	
	Detection	Concentration	UCL *	EPC ^a
	The sheep one and the second se			
SURFACE WATER - UNFILTERED (ug/L)				
PAL METALS			······	
Antimony	3/5	5.6	NA	5.6
Arsenic	4/4	153	NA	153
Barium	5/5	278	NA	278
Manganese	1/1	93	NA	93
PAL SEMIVOLATILE ORGANICS	· · · · · · · · · · · · · · · · · · ·			
Benzo[k]fluoranthene	1/4	0.94	NA	0.94
OTHER				
EPH Fractions				
C11-C22 Aromatics	5/5	650	NA	650
C19-C36 Aliphatics	2/5	1100	NA	1100
VPH Fractions				
C9-C10 Aromatics	1/5	25	NA	25
SURFACE WATER - FILTERED (ug/L)			·	·····
PAL METALS				
Arsenic	5/5	53	NA	53
Manganese	2/2	155	NA	155

Notes:

NOTES:

* The 95% UCL on the arithmetic mean is calculated assuming log-normal distribution of data. Because of the inaccuracy

of the calculation for small data sets, UCLs are not calculated if the data set contains fewer than 10 samples.

^b The EPC is the maximum detected concentration.

ug - micrograms L - liter NA - 95% UCL not applicable to surface water PAL - project analyte list UCL - upper confidence timit

TABLE 9-38 **EXPOSURE PARAMETERS** AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

and the state of a state of the state of the state	POSSIBLE FUTUR	E LAND USE	1. State Henderster	
Provide the state of the second	COMMERCIAL/INDUSTRIAL	CONSTRUCTION		
PARAMETER*	WORKER	WORKER	UNITS	SOURCE
Pail Incention Pain				
Don nigestion kate	100	400	maldas	LISEDA 1004-
	100	480	mg/day	USEPA, 1994a
Central Tendency	20		mg/day	USEPA, 1994a
Fraction Ingested From Site	100%	100%		Assumption
Delection del constitue Tractico	1000/	1000/		
Relative Absorption Factor	100%	100%		Assumption
Inhalation Rate ⁴	1.6	3.3	m²/hour	USEPA, 1997
Exposura Tima	0	0	housedans	TICEDA 1004
	8	<u> </u>	nours/day	USEPA, 1994a;
Exposure Frequency "	150	250	days/year	USEPA, 1994a;
Exposure Duration				
RME	25	0.5	years	USEPA, 1994a
Central Tendency	6.6	0.25	years	USEPA, 1997
Body Weight	70	70	kg	USEPA, 1991a
Averaging Time				
Cancer	70	70	vears	USEPA, 1989b
Noncancer *				
RME	25	0.5	years	USEPA, 1994a
Central Tendency	6.6	0.25	years	Assumption '
Surface Area Exposed				
DME	0250	5200	cm²/day	LICEDA 1090a
Central Tendency	9350	5200	cm ² /day	USEPA, 1989a
Soil Adherence Factor '	0.0087	0.28	mg/cm²	USEPA, 1997
Particulate Emission Factor	1.32E+09	1.32E+09	m /kg	USEPA, 1996b
			~	
Drinking Water Ingestion Rate	1	••	liters/day	USEPA, 1991a
1				

Notes:

1 - RME exposure parameters are used for RME and central tendency scenarios unless separate central tendency exposure parameters are provided.

2 - Inhalation rates are obtained from the Exposure Factors Handbook (USEPA, 1997)
 Commercial/Industrial Worker inhalation rates are based on short-term exposures for moderate activities.
 Construction Worker inhalation rate is based on upper-percentile hourly average for outdoor workers.
 3 - 5 days per week for 50 weeks for the commercial/industrial worker and 5 days per week for 26 weeks for the construction worker.
 4 - The AT for noncarcinogenic effects is equal to the exposure duration; for durations less than one year it is equal

to the 18 week period of construction activity expressed as a fraction of a year

5 - SA and AF values based on highest dermal loading among utility workers, construction workers, and equipment operators. Value conservatively applied to surface area of upper extremeties and head.

6 - Exposure variables with source listed as "assumption" are site specific; the remainder are default values.

7 - Central tendency assumptions are 1/2 the RME value.

mg - milligrams m3 - cubic meters

kg - kilograms RME - Reasonable maximum exposure

-- Not Applicable

TABLE 9-39 ORAL DOSE-RESPONSE DATA FOR CARCINOGENIC EFFECTS AOC 57

the second s	WEIGHT	ORAL		Self-Lord-Self-Self-Self-Self-Self-Self-Self-Self			
	OF	SLOPE FACTOR		TEST	STUDY		
	EVIDENCE	(mg/kg/day)*		SPECIES	ТУРЕ .	TUMOR TYPE	SOURCE
METALS							
Aluminum	Not Listed						HEAST
Antimony	Not Listed						
Arsenic	A	1.5E+00		Human	Oral-DW	Skin	IRIS
Barium	Not Listed						
Cadmium	Bl	ND					IRIS
Chromium	Not Listed						
Copper	D						
Iron	Not Listed						
Lead	B2	ND					IRIS
Manganese	D						IRIS
Vanadium	Not Listed						
PESTICIDES/PCBs							
Dieldrin	B2	1,6E+01		Mouse	Oral-diet	Liver	IRIS
Polychlorinated Biphenyls (PCBs)	B2	See Below	*	Rat	Oral-diet	Liver	IRIS
high risk and persistence-upper bound		2.0E+00					
high risk and persistence-central estimate		1.0E+00					
low risk and persistence-upper bound		4.0E-01					
low risk and persistence-central estimate		3.0E-01					
lowest risk and persistence-upper bound		7.0E-02					
lowest risk and persistence-central estimate		4.0E-02					
SEMIVOLATILES							
1,2-Dichlorobenzene	D						IRIS
1,4-Dichlorobenzene	С	2.4E-02		Mouse	Oral-gavage	Liver	HEAST
Bis(2-ethylhexyl)phthalate	B2	1.4E-02		Mouse	Oral-diet	Liver	IRIS
Benzo(k)fluoranthene	B2	7.3E-02	**				NCEA
Naphthalene	С	ND					IRIS
VOLATILES							
1,2-Dichloroethene (Total)	Not Listed	ND					
Carbon Tetrachloride	B2	1.3E-01		Several	Oral-gavage	Liver	IRIS
Chloroform	B2	6.1E-03		Rat	Oral-DW	Kidney	IRIS
Tetrachloroethene	B2	5.2E-02	W2 N1				NCEA, 1992
Trichloroethene	<u>B2</u>	1.1E-02	W2 N1				HEAST
OTHER			_				
Total Petroleum Hydrocarbon	D	ND					
EPH							
C9-C18 Aliphatics	D	ND					
C19-C36 Aliphatics	D	ND					

TABLE 9-39 ORAL DOSE-RESPONSE DATA FOR CARCINOGENIC EFFECTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	WEIGHT	ORAL	Provide State	CHUNK				
	EVIDENCE	(mg/kg/day)	SPECIES	TYPE	TUMOR TYPE	SOURCE		
C10-C22 Aromatics	D	ND				······		
VPH								
C5-C8 Aliphatics	D	ND						
C9-C12 Aliphatics	D	ND						
C9-C10 Aromatics	D	ND						
NOTES:								
ND - Not Determined	ternined W1 - Value withdrawn from IRIS 4/98.							

ND - Not Determined	W1 - Value withdrawn from IRIS 4/98.
W - Willsbrawn from IRUS	W2 - Value was withdrawn from HEAST in FY 1992 update.
DW - Drinking water	N1 - An NCEA provisional regional value has been published in the
mg - milligrams	USEPA Region III Rsick Based Concentration Table (April 12, 1999)
kg - kilograms	 Applicable to Anoclors 1016, 1248, 1254, and 1260
	 Slope factor for benzo(a)pyrene used for other carcinogenic PAHs,
IRIS - Integrated Risk information System	adjusted by a relative potency factor for benzo(K) fluoranthene of 0.01
HEAST - Health Effects Assessment Summary Tables	Weight of Evidence (Route-Specific):
NCEA - National Center for Environmental Assessment	A - Human carcinogen
	B - Probable human carcinogen (B1 - limited evidence of cancer in humans;
Sources:	B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack
IRIS 25 0(8/99	of evidence in humans)
1(EAST, 1997	C - Possible human careinogen
NCEA 1992	D - Not classifiable as to human carcinogenicity

- E Evidence of lack of careinogenicity to humans

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TABLE 9-40 INHALATION DOSE/RESPONSE DATA FOR CARCINOGENIC EFFECTS AOC 57

	WEIGHT	INHALATION		UNIT					
	OF ···	SLOPE FACTOR	•	RISK	\$	TEST	STUDY		
A second second second second second second second	EVIDENCE	(mg/kg/day)		(hð\ɯ,)	2000	SPECIES .	TYPE-	TUMOR TYPE	SOURCE
METALS									
Aluminum	Not Listed								
Antimony	Not Listed								
Arsenic	A	15	WI	0.0043	-	Human	Inhalation	Lung	IRIS
Barium	Not Listed								
Cadmium	BI	6.3	c	0.0018		Human	Inhalation	Lung	IRIS
Chromium	A	41		0.012		Human	Inhalation	Lung	IRIS
Copper	D								
Iron	Not Listed								
Lead	B2	ND		ND					IRIS
Manganese	D								IRIS
Vanadium	Not Listed								
PESTICIDES/PCBs									
Dieldrin	B2	16		0.0046		Mouse	Oral-diet	Liver	IRIS
Polychlorinated Biphenyls (PCBs)	B2	See Below	**			Rat	Oral-diet	Liver	IRIS
high risk and persistence-upper bound		2							
high risk and persistence-central estimate		1							
low risk and persistence-upper bound		0.4							
low risk and persistence-central estimate		0.3							
lowest risk and persistence-upper bound		0.07							
lowest risk and persistence-central estimate		0.04	<u></u>						
SEMIVOLATILES							<u> </u>		
1,2-Dichlorobenzene	D								IRIS
1,4-Dichlorobenzene	С	0.022	N1	ND					NCEA
Bis(2-ethylhexyl)phthalate (BEHP)	B2	0.014	N2	ND			· · · · · · · · · · · · · · · · · · ·		NCEA
Naphthalene	С			ND					IRIS
VOLATILES									
1,2-Dichloroethene (Total)	Not Listed								
Carbon Tetrachloride	B2	0.053		0.000015		Several	Oral-gavage	Liver	IRIS
Chloroform	B2	0.081		0.000023		Mouse	Oral-gavage	Liver	IKIS
Tetrachloroethene	B2	0.002	N3	0.0000059	W3				NCEA/HEAST
Trichloroethene	B2	0.006	N4	0.0000017	W4				NCEA/HEAST



TABLE 9-40 INHALATION DOSE/RESPONSE DATA FOR CARCINOGENIC EFFECTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	WEIGHT INHALA	ATION UNIT			
 A second process of the second s	OF SLOPE FA	CTOR * RISK	TEST STUDY		
计合约 建立分子 化合金合金 网络合金	EVIDENCE (mg/kg/	'day) (μg/m*) -	SPECIES TYPE	TUMOR TYPE	SOURCE
OTHER					
Total Petroleum Hydrocarbons	D			······································	
ЕРН					
C9-C18 Aliphatics	D				
C19-C36 Aliphatics	D				
C10-C22 Aromatics	D				
VPH					
C5-C8	D				
C9-C12 Aliphatics	D				
C9-C10 Aromatics	D		· · · · · · · · · · · · · · · · · · ·		
ND - Not Determined	* - Source of slope factor is HEAST, 1997 u	inless otherwise noted.			
W - Withdrawn from IRIS	WI - Value withdrawn from HEAST in FY	1997 update.			
mg - milligrams	W2 - Value withdrawn from HEAST in FY	1992 update.			
kg - kilograms	N1 - An NCEA provisional value of 2.2 E-0.	2 has been provided in the USEPA Region III RBC	C Table (April, 1999).		
μg - micrograms	N2 - An NCEA provisional value of 1.4 E-02	2 has been provided in the USEPA Region III RBC	C Table (April, 1999)		

IRIS - Integrated Risk Information System HEAST - Health Effects Assessment Summary Tables

NCEA - National Center for Environmental Assessment

Sources: IRIS as of 8/99 HEAST, 1997 NCEA ** - Slope factors are applicable to Arociors 1016, 1248, 1254, and 1260.

c - Calculated from unit risk [slope = (unit risk x 70 kg)/20 m?/day x 0.001 mg/ug]

N3 - An NCEA provisional value of 2.0 E-03 has been published in the USEPA Region III RBC Table (April, 1999).

N4 - An NCEA provisional value of 6.0 E-03 has been published in the USEPA Region III RBC Table (April, 1999).

Weight of Evidence (Route-Specific):

A - Human carcinogen

B - Probable human carcinogen (B1 - limited evidence of cancer in humans;

B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack

of evidence in humans)

C - Possible human carcinogen

D - Not classifiable as to human carcinogenicity

E - Evidence of lack of carcinogenicity to humans

TAP ORAL DOSE-RESPONSE DATA F AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

where the state of the state of the state of the state	CHRONIC		SUBCHRONIC		1. <u>1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1</u>			1980 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -		
Sector and the sector of the	ORAL		ORAL							
	RID		RfD '		STUDY.	CONFIDENCE		TEST	UNCERTAINTY.	
	(mg/kg-day)		(mg/kg-day)		TYPE	LEVEL	CRITICAL EFFECT	, ANIMAL	FACTOR	SOURCE
METALS										
Aluminum	1E+00	NI	ND							NCEA, 1994a
Antimony	4E-04		0.0004		Oral-DW	Low	Reduced Lifespan	Rat	1000 H,A,L	IRIS
Arsenic	3E-04		3E-04		Oral-DW	Medium	Keratosis and hyperpigmentation	Human	3 H	IRIŠ
Barium	7E-02		7E-02		Oral-DW	Medium	Increased Blood Pressure	Нитал	3 H	IRIS
Cadmium (food)	1E-03		ND		Oral-diet	High	Proteinuria	Human	10 H	IRIS
Cadmium (water)	5E-04		ND		Oral-DW	High	Proteinuria	Human	10 H	IRIS
Chromium	3E-03		2E-02		Oral-DW	Low	No effects observed	Rat	300 H,A,S	IRIS
Copper	(H1)		ND							HEAST
Iron	ND		ND						•	NCEA, 1994c
Lead	ND		ND							IRIS
Manganese (soil)	7.1E-02	÷	ND		Oral-diet	Medium	No effects observed	Human	2, 1M	USEPA, 1996
Manganese (drinking water)	2.4E-02	++	ND						2, 3M	USEPA, 1996
Vanadium	7.0E-03		7E-03		Oral-DW	Low	No effects observed	Rat	100 H,A	HEAST
PESTICIDES/PCBs										
Dieldrin	5E-05		5E-05		Oral-diet	Medium	Liver lesions	Rat	100 H,A	IRIS
Aroclor-1248	2E-05	*	5E-05	*						
Aroclor-1260	2E-05	*	5E-05	*	Oral-diet	Medium	Immunotoxicity	Monkey	300 H,A,S	IRIS
SEMIVOLATILES										
1,2-Dichlorobenzene	9.0E-02		ND		Oral-diet	Low	No adverse effects observed	Rat	1,000 H,A,D	IRIS
1,4-Dichlorobenzene	3E-02	N2	ND				· · · · · · · · · · · · · · · · · · ·			HEAST
Benzo(k)fluoranthene	ND		ND							
Bis(2-ethylhexyl)phthalate	2E-02		2E-02	W1	Oral-diet	Medium	Increased liver weight	Guinea Pig	1,000 H,A,S	IRIS
Naphthalene	2E-02		2E-02		Oral-gavage	Low	Decreased body weight	Rat	3000 H.A.S.D	IRIS
VOLATILES								 		
1,2-Dichloroethylene	9E-03		9E-03		Oral-DW	ND	Liver lesions	Rat	1000	HEAST
Carbon Tetrachloride	7E-04		ND		Oral-gavage	Medium	Liver lesions	Rat	1,000 H,A,S	IRIS
Chloroform	1E-02		1E-02		Oral-capsule	Medium	Fatty cyst formation in liver	Dog	1,000 H,A,S	IRIS
Tetrachloroethene	1E-02		1E-01		Oral-gavage	Medium	Hepatotoxicity	Mouse	1,000 H,A,S	IRIS
Trichloroethene	6E-03	N3	ND							NCEA, 1995
OTHER										
Total Petroleum Hydrocarbons *	3E-02		3E-01							
EPH										
C9-C18 Aliphatics	6E-01		6E+00			.			<u> </u>	MADEP
C19-C36 Aliphatics	6E+00		6E+01							MADEP
C10-C22 Aromatics	3E-02		3E-01							MADEP'
VPH										
C5-C8 Aliphatics	6E-02		6E-01							MADEP ²
C9-C12 Aliphatics	6E-01		6E+00							MADEP ²
C9-C10 Aromatics	3E-02		3E-01							MADEP'

N1 - An NCEA provisional value of 1.0 E +01 has been published in the USEPA Region III RBC Table (April, 1999) N2 - An NCEA provisional value of 3.0 E-02 has been published in the USEPA Region III RBC Table (April, 1999).

- N2 An NCEA provisional value of 6.0 E-03 has been published in the USEPA Region III KBC Table (April, 1999).
 N3 An NCEA provisional value of 6.0 E-03 has been published in the USEPA Region III RBC Table (April, 1999).
- N3 An NCEA provisional value of 6.0 E-03 has been pitolished in the OSEPA Region I WI - Value of 9.0 E-01 was withdrawn from HEAST in FY 1993 update.

HI - Value is the drinking water value (1.3 mg/L) converted to a dose (2 L/day x 1.3 mg/L / 70 kg); not a health-based value.

- Source for all subchronic RfDs is HEAST, 1995
 - ² Interim Final Petroleum Report: Development of Health-Based Alternative to the Total
 - Petroleum Hydrocarbon Parameter and Revisions to the MCP 10/31/97.
 - + RfD based on NOAEL for chronic consumption of manganese divided by
 - 2 to account for dictary exposures.
 - ++ RfD for nondictary exposures adjusted by modifying factor of 3 recommended
 - by IRIS.
 - Value for Aroclor 1254 used as a surrogate.

Uncertainty factors: H - variation in human sensitivity A - animal to human extrapolation S - extrapolation from subchronic to chronic NOAEL L - extrapolation from LOAEL to NOAEL D - Lack of supporting data M - auditional modifying factor SOURCES: IRIS as of 1/97 NCEA, 1994a,b.c, 1995 HEAST, 1995 (including July update) USEPA Region 1 Risk Update, 1996

ND - No data available W - RD withdrawn from IRIS/HEAST mg - milligrams kg - kilograms DW - Drinking Water IRIS - Integrated Risk Information System IELSST - Health Elifest Assessment Summary Tables USEPA - United States Environmental Protection Agency NCEA - Naiceal Center for Environmental Assessment

T4 42 INHALATION DOSE/RESPONSE DA OR NONCARCINOGENIC EFFECTS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	CHRONIC	SUBCHRONIC	CHRONIC	SUBCHRON	C				en e	
New York Court of the State State	INHALATIC	INHALATION	INHALATION	INHALATIO	N					
Contraction of the second second	RIC	DIR	RID ²	RID ²	STUDY	CONFIDENCE		TEST	UNCERTAINTY	r
Contraction of the second second	(mg/m [*])	(mg/m*)	(mg/kg-day)	(mg/kg-day)	TYPE	LEVEL	CRITICAL EFFECT	ANIMAL	FACTOR	SOURCE
METALS										
Aluminum	ND	ND	1.0E-03	NI ND						NCEA
Antimony	ND	ND	ND	ND						
Arsenic	ND	ND	ND	ND						
Barium	5.0E-04	5.0E-03	1.0E-04	1.0E-03	Inhalation	Low	Fetotoxicity	Rat	1000 H,A,S	HEAST
Cadmium	ND	ND	ND	ND						
Chromium	1.0E-04	[I] ND	2.9E-05	ND	Inhalation	Medium	Increase in Lactase Dehydrogenase	Rat	300 H,A,S	IRIS
Copper	ND	ND	ND	ND	-					
Iron	ND	ND	ND	NÐ						
Lead	Dא	[2] ND	ND	ND						IRIS
Manganese	5.0E-05	ND	1.4E-05	ND	Inhalation	Medium	Impaired neurobehavioral function	Human	1,000 H,L,D	IRIS
Vanadium	ND	ND	ND	ND						
PESTICIDES/PCBs										
Dieldrin	ND	ND	ND	ND						
Aroclor-1248	ND	ND	ND	ND						
Aroclor-1260	ND	ND	ND	ND	<u> </u>					
SEMIVOLATILES							······································			
1,2-Dichlorobenzene	2.0E-01	2.0E+00	5.7E-02	[3] 5.7E-01	Inhalation	Low	Decreased weight gain	Rat	1,000 H,A,S	HEAST
1,4-Dichlorobenzenc	8.0E-01	2.5E+00	2.3E-01	7.1E-01	Inhalation	Medium	Increased liver weight	Rat	100 H,A,S	IRIS
Bis(2-ethylbexyl)phthalate	ND	ND	ND	ND						
Naphthalene	3.0E-03	3.0E-03	8.5E-04	8.5E-04	Inhalation	Medium	Hyperplasia and metaplasis in respiratory and olfacotry epithelium	Rat	3,000 H,A,S,D	IRIS
VOLATILES										
1,2-Dichloroethylene (Total)	ND	ND	ND	ND						
Carbon Tetrachloride	ND	ND	5.7E-04	N2 ND						NCEA
Chloroform	ND	ND	8.6E-05	N3 ND						NCEA
Tetrachloroethene	ND	ND	1.4E-01	N4 ND						NCEA
Trichloroethene	ND	ND	ND	ND						IRIS
OTHER										
Total Petroleum Hydrocarbons	ND	ND	ND	ND				·		
EPH										MADEDI
C9-C18 Aliphatics	2.0E+00	2.0E+01	5.7E-01	5.7E+00			· · · · · · · · · · · · · · · · · · ·	·		MADEP
C19-C36 Aliphatics	ND	ND	ND	ND						MADEP
C11-C22 Aromatics	7.1E-02	7.1E-01	2.0E-02	2.0E-01						MADEP
VPH										MADEN
C5-C8 Aliphatics	2.0E-01	2.0E+00	5.7E-02	5.7E-01						MADEN
C9-C12 Aliphatics	2.0E+00	2.0E+01	5.7E-01	5.7E+00						MADEP
C9-C10 Aromatics	6.0E-02	6.0E-01	1.7 <u>E</u> -02	1.7E-01						MADEF

ND - No data available mg - milligram kg - kilogram IRIS - Integrated Risk Information System HEAST - Health Effects Assessment Summary Tables USEPA - United States Environmental Protection Agency

 ¹ - Source for all subchronic RCs is HEAST, 1997

 ² - RD calculated from RSC as follows:

 RD (mg/kg-d) = RC (mg/m³) 70 kg x 20 m³/d

 on System
 ³ - HEAST Table 1: Subchronic and Chronic Toxicity

 ment Summary Tables
 ⁴ - Interim Final Petroleum Report:Development of Health-Based

 mental Protection Agency
 Alternative to the Total Petroleum Hydrocarbon Parameter (1994).

 and revisions to the MCP 10/03/197.
 20

 N1 - An NCEA provisional support value of 1.0 E-3 has been published in the USEPA Region III RBC Table (April, 1999).

 N2 - An NCEA provisional support value of 5.7 E-4 has been published in the USEPA Region III RBC Table (April, 1999).

 N3 - An NCEA provisional support value of 5.6 E-5 has been published in the USEPA Region III RBC Table (April, 1999).

 N4 - An NCEA provisional support value of 1.4 E-1 has been published in the USEPA Region III RBC Table (April, 1999).

 mlth-Based
 [1] Value is for chromium particulates; value for Chromium VI as dissolved Chromium VI accesses or chromic acid mists is 8E-6 mg/m³

 rel (1994).
 aerosols or chromic acid mists is 8E-6 mg/m³

 [2] - There is a National Ambient Air Quality Standard for lead
 of 1.5 µg/m³ averaged over three months

[3] Rfd calculated from RfC - HEAST Table 2

SOURCES: IRIS as of 8/99 HEAST, 1997 Uncertainty factors:

H - variation in human sensitivity

A - animal to human extrapolation

D - Lack of supporting data

L - extrapolation from LOAEL to NOAEL

S - extrapolation from subchronic to chronic NOAEL



Tr. E 9-43

DERMAL DOSE-RESPONSE DATA FOR CARCINOGENIC AND NONCARCINOGENIC EFFECTS

AOC 57

and a second	en ander alle and an and a second second	CHRONIC	CHRONIC	SUBCHRONIC	SUBCHRONIC		ADJUSTED
	ORAL	ORAL	DERMAL	ORAL	DERMAL	ORAL	DERMAL
	ABSORPTION	RfD ²	RD ³	RfD ²	RfD ³	CSF ²	CSF ⁴
	EFFICIENCY*	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)*	(mg/kg-day)
METALS							
Aluminum	ND	1.0E+00		ND		ND	
Antimony	0.15	4.0E-04	6.0E-05	4.0E-04	6.0E-05	ND	
Arsenic	0.95	3.0E-04	2.9E-04	3.0E-04	2.9E-04	1.5E+00	1.6E+00
Barium	0.07	7.0E-02	4.9E-03	7.0E-02	4.9E-03	ND	
Cadmium (food)	0.03	1.0E-03	3.0E-05	ND		ND	
Cadmium (water)	0.05	5.0E-04	2.5E-05	ND		ND	
Chromium	0.025	3.0E-03	7.5E-05	2.0E-02	5.0E-04	ND	
Copper	0.57	ND		ND		ND	us
Iron	ND	ND		ND		ND	-
Lead	ND	ND		ND		ND	
Manganese (soil)	0.06	7.1E-02	4.3E-03	ND		ND	
Manganese (drinking water)	0.06	2.4E-02	1.4E-03	ND		ND	<u></u>
Vanadium	0.026	7.0E-03	1.8E-04	7.0E-03	1.8E-04	ND	
PESTICIDES/PCBs							
Dieldrin	ND	5.0E-05		5.0E-05		1.6E+01	
Polychlorinated Biphenyls (PCBs)	0.8	2.0E-05	1.6E-05	5.0E-05	4.0E-05	2.0E+00	2.5E+00
SEMIVOLATILES							
Bis(2-ethylhexyl)phthalate	ND	2.0E-02		2.0E-02		1.4E-02	
Polyaromatic Hydrocarbons (PAHs)	0.89						
Benzo(k)fluoranthene		ND		ND		7.3E-02	8.2E-02
Naphthalene		2.0E-02	1.8E-02	2.0E-02	1.8E-02	ND	
VOLATILES							
1,2-Dichloroethylenes	ND	9.0E-03		9.0E-03		ND	
Chloroform	ND	1.0E-02		1.0E-02		6.1E-03	
Tetrachloroethylene	ND	1.0E-02		1.0E-01		5.2E-02	
Trichloroethylene	ND	6.0E-03		ND		1.1E-02	
OTHER				- 			
<u>VPH</u>							
C5-C8 Aliphatics	0.91	6.0E-02	5.5E-02	6.0E-01	5.5E-01	ND	
C9-C12 Aliphatics	0.91	6.0E-01	5.5E-01	6.0E+00	5.5E+00	ND	
C9-C10 Aromatics	0.91	3.0E-02	2.7E-02	3.0E-01	2.7E-01	ND	

TABLE 9-43

DERMAL DOSE-RESPONSE DATA FOR CARCINOGENIC AND NONCARCINOGENIC EFFECTS

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	ORAL ABSORPTION EFFICIENCY	CHRONIC ORAL RfD ² (mg/kg-day)	CHRONIC DERMAL RID ³ (mg/kg-day)	SUBCHRONIC ORAL RD ² (mg/kg-day)	SUBCHRONIC DERMAL RID ³ (mg/kg-day)	ORAL CSF ² (mg/kg-day)'	ADJUSTED DERMAL CSF ⁴ (mg/kg-day)
алы солонын наласын наласын каланын аларын аларын каланан каланан каланан калан калан калан калан калан калан к	Weddingel of Andrew and Annothening Annothening and an annual for a first						
C9-C18 Aliphatics	0.91	6.0E-01	5.5E-01	6.0E+00	5.5E+00	ND	
C19-C36 Aliphatics	0.91	6.0E+00	5.5E+00	6.0E+01	5.5E+01	ND	
C11-C22 Aromatics	0.91	3.0E-02	2.7E-02	3.0E-01	2.7E-01	ND	

NOTES:

¹ Values based on Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance

Dermal Risk Assessment Interim Guidance, May 7, 1998. Values for EPH/VPH derived from relative absorption factor (MADEP, 1997).

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²See Dose-Response Tables; Chronic RfD

used if no subchronic RfD available.

³ Dermal RfD = Oral RfD x Oral Absorption Efficiency

⁴ Dermal CSF = Oral CSF / Oral Absorption Efficiency

RID - Reference Dose

CSF - Cancer Slope Factor
TABLE 9-45 POTENTIAL SOURCES OF UNCERTAINTY AOC 57

UNCERTAINTY	EFFECT.	JUSTIFICATION
Likelihood of exposure pathways	Overestimate	Future exposures may not actually occur
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time as a result of degradation, so future exposures may be to lower concentrations.
Extrapolation of animal toxicity data to humans	Unknown, probably overestimate	Animals and humans differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical. Animal studies typically involve high-dose exposures, whereas humans are exposed to low doses in the environment.
Use of linearized, multistage model to derive cancer slope factors	Overestimate	Model assumes a non-threshold, linear-at-low-dose relationship for carcinogens. Many compounds induce cancer by non-genotoxic mechanisms. Model results in a 95% upper confidence limit of the cancer risk. The true risk is unlikely to be higher and may be as low as zero.
Summation of effects (cancer risks and hazard indices) from multiple substances	Unknown	The assumption that effects are additive ignores potential synergistic and/or antagnonistic effects. Assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce tumors or other toxic effects in different organs or systems.
Use of uncertainty factors in the derivation of reference doses.	Unknown	Ten-fold uncertainty factors are incorporated to account for various sources of uncertainty. Although some data seem to support the ten-fold factor, its selection is somewhat arbitrary.
The use of an oral absorption factor of 1	Overestimate	The assumption of 100% gastrointestinal absorption of chemicals on soil is conservative.

TABLE 9-46 ENDPOINTS FOR ECOLOGICAL ASSESSMENT AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

MEDIUM	RECEPTOR	ASSESSMENT ENDPOINT	MEASUREMENT ENDPOINT
Surface Soil (upland and floodplain)	Wildlife	Survival and propagation of wildlife populations.	Oral contaminant doses (mg/kg BW-day) based on measured adverse effects on growth, reproduction, or survival (e.g., LD50 studies, LOAELs, and NOAELs) of mammalian or avian laboratory test populations.
	Terrestrial invertebrates	Survival and propagation of terrestrial invertebrate popula- tions.	Contaminant concentrations in surface soil (μ g/g) that measure adverse effects on survival (e.g., LC50 studies) of terrestrial in- vertebrates. When no survival studies are available, measured adverse effects on reproduction and growth are used.
	Terrestrial plants	Survival and propagation of plant populations.	Contaminant concentrations in surface soil ($\mu g/g$) that measure adverse effects on growth, reproduction, or survival of terrestrial plants.
Surface Water and Sediment	Wildlife	Survival and propagation of wildlife populations.	Oral contaminant doses (mg/kg BW-day) based on measured adverse effects on growth, reproduction, or survival (e.g., LD ₅₀ studies, LOAELs, or NOAELs) of mammalian or avian labora- tory test populations.
Surface Water	Aquatic organisms (small fish, invertebrates, plants, and amphibians)	Survival and propagation of small fish, invertebrate, amphib- ian, and aquatic plant popula- tions.	Chemical concentrations in surface water (µg/l) associated with adverse effects to growth, reproduction, survival, and biodive- rsity of aquatic organisms.
Sediment	Aquatic organisms (small fish, invertebrates, plants, and amphibians)	Survival and propagation of small fish, invertebrate, amphib- ian, and aquatic plant popula- tions.	Chemical concentrations in sediment $(\mu g/g)$ associated with adverse effects to growth, reproduction, and survival of aquatic organisms.
	Aquatic invertebrates	Survival and propagation of benthic macroinvertebrate pop- ulations.	Direct measurement of survival and growth of the midge (<i>Chironomus tentans</i>) and amphipod (<i>Hyalella azteca</i>) in laboratory toxicity tests.
Groundwater dis- charge to the surface	Aquatic organisms (small fish, invertebrates, plants, and amphibians)	Future survival and propagation of small fish, invertebrate, amphibian, and aquatic plant populations.	Current chemical concentrations in surface water (µg/l) and sediment (mg/kg) in Cold Spring Brook in the vicinity of the Bower's Brook junction

NOTES:

µg/g=micrograms per gramµg/l=micrograms per litermg/kg BW-day=milligrams per kilogram of body weight per dayLDso=lethal dose to 50 percent of a test populationLCso=lethal concentration to 50 percent of a test populationLOAEL=Lowest Observed Adverse Effect Concentration.NOAEL=No Observed Adverse Effect Concentration.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 UPLAND SURFACE SOIL

AOC 57

	Frequency		Range of	Background		Average	Exposu	ire Point
	of	Range of	Detected	Surface Soil	Analyte	ot all	Concer	trations
ANALYTE	Detection ²	SQLs ^a	Concentrations	Concentrations	a CPC?*	Concentrations	RME	Average
PAL METALS (μg/g)								
Aluminum	5/5	NA	3,920 to 7,530	18,000	NO *			
Arsenic	5/5	NA	7.9 to 21	19	YES	14.5	21	14.5
Barium	5/5	NA	18.8 to 40.9	54	NO *			
Beryllium	1/5	0.5	0.71	0.81	NO *			
Calcium	5/5	NA	134 to 889	810	NO "			
Chromium	5/5	NA	7.7 to 27	33	NO °			
Cobalt	5/5	NA	1.9 to 7.5	4.7	YES	4.6	7.5	4.6
Copper	5/5	NA	4.1 to 15.6	13.5	YES	11	15.6	11
Iron	5/5	NA	7,030 to 16,400	18,000	NO SI II			
Lead	5/5	NA	8.1 to 22.9	48	NO "			
Magnesium	5/5	NA	926 to 4,020	5,500	NO ^{3,10}			
Manganese	5/5	NA	79.2 to 481	380	YES	282	481	282
Nickel	5/5	NA	6.6 to 30.7	14.6	YES	16.8	30.7	16.8
Potassium	5/5	NA	144 to 1,170	2,400	NO */**			
Selenium	1/5	0.25	0.88	NA	YES	0.28	0.88	0.28
Sodium	5/5	NA	260 to 436	131	NO "			
Vanadium	5/5	NA	7.6 to 15.5	32.3	NO [®]			
Zinc	5/5	NA	13.7 to 38.1	43.9	NO *			
PESTICIDES/PCBs (µg/g)								0.0070
4,4'-DDE	1/5	0.0077	0.020	NA	YES	0.0070	0.020	0.0070
4,4'-DDT	1/5	0.0071	0.026	NA	YES	0.0080	0.026	0.0080
PAL SEMIVOLATILE ORGANIC	:S (µg/g)							
2-Methylnaphthalene	2/5	0.05 to 0.20	0.40 to 0.43	NA	YES	0.20	0.43	0.20
Bis(2-ethylhexyl)phthalate	2/5	0.62 to 3.0	2.0 to 2.7	NA	YES	1.6	2.7	1.6
Dibenzofuran	1/5	0.04 to 0.20	0.16	NA	YES	0.083	0.16	0.083
Fluoranthene	3/5	0.30	0.097 to 0.30	NA	YES	0.16	0.30	0.16
Naphthalene	3/5	0.04 to 0.20	0.1 to 0.42	NA	YES	0.21	0.42	0.21
Phenanthrene	4/5	0.20	0.045 to 0.28	NA	YES	0.15	0.28	0.15
Pyrene	4/5	0.20	0.087 to 0.40	NA	YES	0.18	0.40	0.18
PAL VOLATILE ORGANICS (µg	ı/ç							
Chloroform	1/5	0.00087	0.00089	NA	YES	0.00053	0.00089	0.00053
Ethylbenzene	1/5	0.0017	0.0024	NA	YES	0.0012	0.0024	0.0012

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 UPLAND SURFACE SOIL'

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	-	Range of	Background	A	Average	Exposi	ire Point
ANALYTE	ot Detection ²	Kange bi SQLs ^a	Concentrations	Concentrations ⁴	a CPC? ⁵	Concentrations ⁶	RME	Average ¹
Tetrachloroethylene	1/5	0.00081	0.0030	NA	YES	0.00092	0.0030	0.00092
Toluene	3/5	0.00078	0.0016 to 0.0037	NA	YES	0.0017	0.0037	0.0017
Trichlorofluoromethane	3/5	0.0059	0.0073 to 0.017	NA	YES	0.0075	0.017	0.0075
Xylenes	1/5	0.0015	0.029	NA	YES	0.0064	0.029	0.0064
OTHER (µg/g)								
Total Petroleum Hydrocarbons	5/5	NA	25 to 8,000	NA	YES	1,700	8,000	1,700

Notes:

¹ Sample locations include: 57B-95-01X, 57B-95-02X, 57E-95-02X, 57E-95-10X, and 57E-95-25X (all collected from 0 to 2 feet below ground surface).

² Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

³ Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

⁴ Inorganic background concentrations from the Ft. Devens background surface soil database (developed in 1993) were used to screen CPCs.

^a Contaminant of Potential Concern (CPC) for wildlife receptors.

⁶ The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

' Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

* Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

⁹ Maximum concentration is less than the background concentration.

¹⁰ Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

 μ g/g = micrograms per gram AOC = Area of contamination.

CPC = Contaminant of potential concern.

NA = Not available.

PAL = Project analyte list.

RME = Reasonable maximum exposure.

SQL = Sample quantitation limit.

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SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 FLOODPLAIN SURFACE SOIL

AOC 57

	Frequency			Range	of	Background		Average	Q5th %	Exposu	e Point
ANALYIE	OF Detection ²	Rant SOI	10 OL 5 ³	Concentr	ations	Concentration ⁴	a CPC? ⁵	Concentrations	UCL	RME ⁸	Average:
PAL METALS (µg/g)			<u></u>								
Aluminum	3/3		NA	3,140 to	6,180	18,000	NO 10				
Antimony	1/11	1.1 to	7.1		1.6	0.5	YES	2.8	5.9	1.6	1.6
Arsenic	11/11		NA	7.0 to	61.2	19	YES	24.1	47.9	47.9	24.1
Barium	11/11		NA	10.7 to	113	. 54	YES	47.9	106	106	47.9
Beryilium	1/3		0.5		0.71	0.81	NO ¹⁰				
Calcium	3/3		NA	255 to	528	810	NO ^{10,11}				
Chromium	3/3		NA	9.0 to	15.4	33	NO ¹⁰				
Cobalt	3/3		NA	1.9 to	2.3	4.7	NO ¹⁰				
Copper	11/11		NA	2.5 to	41.3	13.5	YES	15.6	39.3	39.3	15.6
lron	3/3		NA	5,390 to	7,920	18,000	NO ^{10, 11}				
Lead	11/11		NA	18.7 to	320	48	YES	143	459	320	143
Magnesium	3/3		NA	1,120 to	1,390	5,500	NO 10,11				
Manganese	11/11		NA	36.7 to	679	380	YES	149	273	273	149
Nickel	3/3		NA	6.1 to	10.4	14.6	NO ¹⁰				
Potassium	3/3		NA	327 to	460	2,400	NO ^{10,11}				
Selenium	9/11		0.25	0.39 to	4.4	NA	YES	1.9	12.1	4.4	1.9
Sodium	3/3		NA	294 to	446	131	NO ¹¹				
Vanadium	3/3		NA	5.7 to	14	32.3	NO ¹⁰				
Zinc	10/11		8.0	14.9 to	150	43.9	YES	55.1	183	150	55.1
PESTICIDES/PCBs (ug/a)											
4,4'-DDD	1/11		0.0083		0.037	NA	YES	0.0071	0.010	0.010	0.0071
4,4'-DDE	4/11		0.0077	0.0093 to	0.052	NA	YES	0.013	0.034	0.034	0.013
4,4'-DDT	4/11		0.0071	0.035 to	0.18	NA	YES	0.039	0.43	0.18	0.039
Aroclor-1260	8/11		0.080	0.19 to	4.2	NA	YES	0.63	3.5	3.0	0.03
Dieldrin	4/11		0.0063	0.013 to	0.032	NA	TES	0.0099	0.025	0.025	0.0055
PAL SEMIVOLATILE ORGANICS (µg/g)											
2-Methylnaphthalene	1/11	0.049 to	0.50		0.60	NA	YES	0.18	0.38	0.38	0.18
Acenaphthylene	1/11	0.033 to	0.30		0.40	NA	YES	0.13	0.20	0.20	0.13
Benzo[k]fluoranthene	1/11	0.066 to	0.70		1.0	NA	YES	0.27	0.00	0.00	0.27
Chrysene	1/11	0.12 to	1.0		2.0		VES	0.33	0.77	0.77	0.33
UI-n-butyiphinalate	2/11		0.00	10 to	20	NA	YES	0.58	2,7	2.0	0.58
	1/11	0.037 to	0.40	1.0 10	0.40	NA	YES	0.14	0.30	0.30	0.14
Phenanthrene	5/11	0.033 to	0.30	0.30 to	1.0	NA	YES	0.39	2.3	1.0	0.39
Pvrene	5/11	0.033 to	0.30	0.40 to	2.0	NA	YES	0.63	6.6	2.0	0.63

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 FLOODPLAIN SURFACE SOIL

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

ANALYTE	Frequency	Range of	Range of Detected	Background Surface Soll	Analyte	Average of all	95th %	Exposu Concen	e Point
	Detection ²	\$QLs ³	Concentrations	Concentration	a CPC?	Concentrations	UCL	RME *	Average
PAL VOLATILE ORGANICS (ug/g)									
1.2-Dichloroethylene (cis and trans)	2/11	0.0030	0.01 to 0.016	NA	YES	0.0036	0.0069	0.0069	0.0036
Acetone	2/11	0.017	0.073 to 0.33	NA	YES	0.029	0.067	0.067	0.029
Ethylbenzene	2/11	0.0017	0.0033 to 0.022	NA	YES	0.003	0.0059	0.0059	0.003
Methylene Chloride	1/11	0.012	0.015	NA	YES	0.0068	0.0081	0.0081	0.0068
Tetrachloroethylene	2/11	0.0008	0.0011 to 0.0047	NA	YES	0.0009	0.0014	0.0014	0.0009
Toluene	2/11	0.0008	0.0072 to 0.0083	NA	YES	0.0017	0.0051	0.0051	0.0017
Trichlorofluoromethane	3/11	0.0059	0.0073 to 0.014	NA	YES	0.0048	0.0072	0.0072	0.0048
OTHER (µg/g)									
Total Petroleum Hydrocarbons	11/11	NA	169 to 17,000	NA	YES	3,500	20,000	17,000	3,500

Notes:

1 Sample locations include: 57E-95-12X, 57E-95-16X, 57E-95-17X (all collected from 0 to 2 feet below ground surface), 57S-98-01X, 57S-98-02X, 57S-98-04X, and 57S-98-06X through

57S-98-09X (all collected from 0-1 feet below the ground surface). 57S-98-07X also includes a sample collected from 1-2 feet below ground surface.

2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

4 Inorganic background concentrations from the Ft. Devens background surface soil database (developed in 1993) were used to screen CPCs.

5 Contaminant of Potential Concern (CPC) for wildlife receptors.

6 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

7 The 95th percent UCL was calculated for data sets with 10 or more samples, and is calculated using the log-transformed average of all concentrations (assuming a log normal distribution).

8 Reasonable Maximum Exposure (RME) concentrations are equal to the lesser of the maximum detected concentration and the 95th percent UCL, when more than 10 samples were collected.

The RME is equal to the maximum detected concentration when less than 10 samples were collected.

9 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

10 Maximum concentration is less than the background concentration.

11 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram

AOC = Area of contamination.

CPC = Contaminant of potential concern.

NA = Not available.

PAL = Project analyte list.

- RME = Reasonable maximum exposure.
- SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE SOIL¹

AOC 57

	Frequency			Ran	je of	Background	Analide	Average	Exposi	ire Point
ANALTIE	Detection ²	SOLs ³		Concen	cleu trations	Concentration ⁴	a CPC? ⁵	Concentrations *	RME ⁷	Average ⁸
PAL METALS (µg/g)										
Aluminum	2/2	N	A 6	,370 to	7,100	18,000	NO ⁹			
Arsenic	4/4	N	Ą	5.2 to	41	19	YES	25.0	41	25.0
Barium	4/4	N	A	11.1 to	29.3	54	NO ⁹			
Cadmium	1/2	0.1	7		1.5	1.28	YES	0.93	1.5	0.93
Calcium	1/2	10	00		283	810	NO ^{9,10}			
Chromium	2/2	N	Ą	10.6 to	11.7	33	NO ⁹			
Cobalt	2/2	NA	Ą	2.4 to	3.2	4.7	NO ⁹			
Copper	4/4	NA	۹	2.9 to	6.8	13.5	NO ⁹			
lron	2/2	NA	A 7	,430 to	8,040	18,000	NO ^{9,10}			
Lead	3/4	10).5	7.8 to	32.7	48	NO ⁹			
Magnesium	2/2	NA	A 1	,540 to	1,650	5,500	NO ^{9,10}			
Manganese	4/4	NA	A.	69.5 to	548	380	YES	219	548	2.19
Nickel	2/2	NA	4	10.5 to	11.1	14.6	NO ⁹			
Potassium	2/2	NA	4	209 to	683	2,400	NO ^{9,10}			
Selenium	1/4	0.:	25		1.6	NA	YES	0.48	1.6	0.48
Sodium	2/2	NA	4	400 to	435	131	NO ¹⁰			
Vanadium	2/2	NA	۹.	9.2 to	9.4	32.3	NO ⁹			
Zinc	4/4	NA	4	15.8 to	28.5	43.9	NO ⁹			
PESTICIDES/PCBs (ua/a)										
4,4'-DDD	2/5	0.0	0083 0.	.0234 to	0.27	NA	YES	0.061	0.27	0.061
4 4'-DDE	1/5	0.0077 to 0.0	05		0.0081	NA	YES	0.0089	0.0081	0.0081
4,4'-DDT	2/5	0.0071 to 0.0	05 0.	.0121 to	0.025	NA	YES	0.014	0.025	0.014
Chlordane - Alpha	1/4	0.0013 to 0.0	005		0.0028	NA	YES	0.0021	0.0028	0.0021
Chlordane - Gamma	1/4	0.0013 to 0.0	005		0.0028	NA	YES	0.0021	0.0028	0.0021
Aroclor-1260	1/5	0.025 to 0.0	0804		0.47	NA	YES	0.12	0.47	0.12
PAL SEMIVOLATILE ORGANIC	CS (µg/g)									
1,2-Dichlorobenzene	1/4	0.1	11		0.35	NA	YES	0.13	0.35	0.13
1,4-Dichlorobenzene	1/4	0.0	098		0.48	NA	YES	0.16	0.48	0.16
Fluoranthene	2/5	0.068 to 2.2	2	0.13 to	0.14	NA	YES	0.29	0.14	0.14
Naphthalene	1/5	0.037 to 2.2	2		0.048	NA	YES	0.89	0.048	0.048

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE SOIL¹ AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency of	Rang	eof	Ran Dete	ge of cted	Background Surface Soil	Analyte	Average of all	Exposi Conce	ure Point intrations
	Detection ²	SQL	5	Concer	itrations	Concentration 4	a CPC? ⁵	Concentrations *	RME ⁷	Average ⁸
Phenanthrene	2/5	0.033 to	2.2	0.067 to	0.11	NA	YES	0.26	0.11	0.11
Pyrene	2/5	0.033 to	2.2	0.096 to	0.15	NA	YES	0.28	0.15	0.15
PAL VOLATILE ORGANICS (ug/g)										
Chlorobenzene	1/4		0.0009		0.012	NA	YES	0.0033	0.012	0.0033
Toluene	2/4	0.0008 to	310	0.0017 to	0.0030	NA	YES	0.0014	0.0030	0.0014
Trichloroethylene	1/4		0.0028		0.0042	NA	YES	0.0021	0.0042	0.0021
EPH/VPH (ya/a)										
Eph C11-C22 Aromatics	2/2		NA	60 to	75	NA	YES	70	75	70
Eph C19-C36 Aliphatics	2/2		NA	150 to	180	NA	YES	170	180	170
Vph C9-C10 Aromatics	1/2		NA		3.7	NA	YES	2.2	3.7	2.2
OTHER (µg/g)										
Total Petroleum Hydrocarbons	10/11		1,400	39 to	2,900	NA	YES	850	2,900	850

Notes:

1 Sample locations include: EX57W15X, 57B-95-08X, 57B-95-09X, 57S-98-11X through 57S-98-16X (all collected from 0 to 1 feet below ground surface), and 57S-98-12X, through 57S-98-14X (collected 1 to 2 feet below ground surface).

2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

4 Inorganic background concentrations from the Ft. Devens background surface soil database (developed in 1993) were used to screen CPCs.

5 Contaminant of Potential Concern (CPC) for wildlife receptors.

6 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

7 Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; except for TPHC the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set. The 95% UCL for TPHC is greater than the maximum detected concentration.

8 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

9 Maximum concentration is less than the background concentration.

10 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/g = micrograms per gram

- AOC = Area of contamination.
- CPC = Contaminant of potential concern.
- NA = Not available.
- PAL = Project analyte list.
- RME = Reasonable maximum exposure.
- SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SURFACE WATER ¹ AOC 57

ANALYTE	Frequency	Range of	Range of Detected	Upgradient Surface Water	Analyte	Average of all	Exposun Concent	e Point ations
	Detection ²	SQLs ³	Concentrations	Concentration 4	a CPC? ⁵	Concentrations ⁶	RME	Average ^a
PAL UNFILTERED METALS (µg/L)	5/6	1/1	156 to 15 100	ND	YES	2,650	15,100	2.650
Arsenic	9/9	NA	4.1 to 198	5.4	YES	50.6	198	50.6
Barium	9/9	NA	12.2 to 553	12.6	YES	155	553	155
Cadmium	1/6	4.0	24.6	ND	YES	5.8	24.6	5.8
Calcium	6/6	NA	18,400 to 28,700	24,300	NO ⁹		05.0	0.5
Chromium	1/6	6.0	35.8	ND	YES	0.0 74.0	30.0	0,0 74 0
Copper	4/9	8.1	60.4 to 375	9.0	VES	74.9 5.840	17 600	5 840
lron Lood	0/0 7/0	13	1.5 to 967	ND	YES	243	967	243
Maanasium	6/6	NA	1 290 to 4 930	3.630	NO ⁹			
Manganese	6/6	NA	123 to 433	131	YES	243	433	243
Mercurv	1/6	0.24	0.24	ND	YES	0.14	0.24	0.14
Potassium	6/6	NA	1,320 to 3,840	1,630	NO ⁹			
Selenium	1/9	2 to 3.02	2.4	ND	YES	1.5	2.4	1.5
Sodium	6/6	NA	17,800 to 60,900	19,200	NO ⁹			
Vanadium	1/6	11	72.3	ND	YES	16.6	72.3	16.6
Zinc	5/9	21.1	109 to 712	ND	YES	180	712	180
PAL FILTERED METALS (ug/L)								
Arsenic	4/5	2.5	3.4 to 8.9	4.4	YES	4.4	8.9	4.4
Barium	5/5	NA	11.7 to 43.1	11.9	YES	21.7	43.1	21.7
Calcium	4/4	NA	11,800 to 24,000	24,100	NO ^{9,10}			
Iron	4/4	NA	194 to 17,200	254	YES	4,540	17,200	4,540
Lead	1/5	1.3 to 50	2.3	ND	YES	5.8	2.3	5.8
Magnesium	4/4	NA	1,050 to 3,550	3,610	NO ^{9,10}			
Manganese	4/4	NA	64.2 to 483	107	YES	197	483	197
Potassium	4/4	NA	1,490 to 2,430	1,700	NO ⁹			
Sodium	4/4	NA	15,800 to 56,900	19,000	NO ⁹			
Zinc	1/5	21.1 to 35.8	58.4	NA	YES	21.6	58.4	21.6

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SURFACE WATER ¹

AOC 57

	Frequency		Range of	Upgradient		Average	Ехрози	e Point
ANALYTE	¢f	Range of	Detected	Surface Water	Analyte	ofall	Concen	rations
	Detection ²	SQLs ³	Concentrations	Concentration	a CPC?	Concentrations	RME	Average
PAL SEMIVOLATILE ORGANICS (µg	g/L)							
Bis(2-ethylhexyl)phthalate	1/9	4.8	24	ND	YES	4.8	24	4.8
Phenanthrene	1/9	0.5	0.52	ND	YES	0.28	0.52	0.28
PAL VOLATILE ORGANICS (µg/L)				-				
1,2-Dichloroethylenes (cis and trans)	1/9	0.5	26	ND	YES	3.1	26	3.1
Carbon disulfide	1/9	0.5	1.1	ND	YES	0.34	1.1	0.34
Chloroform	1/9	0.5	0.72	ND	YES	0.30	0.72	0.30
Methylene chloride	3/9	2.3	2.3 to 4.1	3.0	YES	1.8	4.1	1.8
Tetrachloroethylene	2/9	1.6	1.8 to 2.6	ND	YES	1.11	1.8	1.11
Toluene	1/9	0.5	1.1	0.42	YES	0.34	1.1	0.34
Trichloroethylene	2/9	0.5	0.6 to 3.5	ND	YES	0.65	3.5	0.65
WET CHEMISTRY (µg/L)								
Alkalinity	6/6	NA	13,000 to 36,000	35,300	YES	29,700	36,000	29,700
Chloride	6/6	NA	25,200 to 100,000	44,000	YES	50,200	100,000	50,200
Nitrite, Nitrate-non Specific	4/6	10	130 to 152	128	NA	к		
Nitrogen By Kjeldahl Method	5/6	183	276 to 16,000	639	NA			
Phosphate	6/6	NA	18.8 to 1,000	49.2	NA			
Sulfate	6/6	NA	11,000 to 13,000	13,000	NA			
Total Dissolved Solids	6/6	NA	125,000 to 234,000	160,000	NA	162,000		
Total Hardness	6/6	NA	85,000 to 110,000	107,000	NA	100,000		
Total Suspended Solids	8/8	NA	4,000 to 10,500,000	39,800	YES	1,700,000	10,500,000	1,700,000
OTHER (µg/L)								
Total Petroleum Hydrocarbons	2/6	168 to 176	247 to 924	ND	YES	252	924	252
EPH								
C11-C22 Aromatics	3/3	NA	380 to 1,400	NA	YES	797	1,400	797
C19-C36 Aliphatics	3/3	NA	750 to 1,700	NA	YES	1,280	1,700	1,280

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SURFACE WATER¹

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Fractionever	kanne or		Average Exposite Point
	Hanno of Hetecter	Surface Water Analyte	oncontrations
	370100		
	Corcontration	Concontration?	Concontrations DMC Average
	ages concentrations	CONCERNIATION A CEC.	- Currentionous - Current - Average

Notes:

¹ Sample locations include: 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57W-98-01X through 57W-98-03X. Filtered samples were collected at 57W-95-04X through 57W-95-06X, 57W-95-10X, and 57W-98-01X.

² Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

³ Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

⁴ The arithmetic mean of inorganic concentrations detected in upgradient samples was used to screen surface water CPCs. Upgradient sample locations include 57W-95-03X and -08X.

⁵ Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

⁶ The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

⁷ Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

⁸ Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

⁹ Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

¹⁰ Maximum concentration is less than the average upgradient concentration.

μg/L = micrograms per liter AOC = Area of contamination. CPC = Contaminant of potential concern. NA = Not available. ND = Not detected. PAL = Project analyte list. RME = Reasonable maximum exposure. SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE WATER¹

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

ΔΝΑΙΧΤΕ	Frequency	Randelof	Range of Detected	Upgradient Surface Water	Analyte	Average of all	Expos Conce	ure Point ntrations
	Detection ²	SQLs 3	Concentrations	Concentration 4	a CPC?5	Concentrations	RME ⁷	Average *
PAL UNFILTERED METALS (µg/L)								
Antimony	3/5	1	2.0 to 5.6	NA	YES	2.1	5.6	2.1
Arsenic	4/4	NA	5.6 to 153	5.4	YES	49.1	153	49.1
Barium	5/5	NA	42.8 to 278	12.6	YES	176	278	176
Copper	4/5	5	19.2 to 44.1	9.0	YES	23.9	44.1	23.9
Lead	5/5	NA	27.8 to 184	NA	YES	92.4	184	92.4
Manganese	1/1	NA	92.8	131	NO ¹⁰			
Selenium	2/5	2	2.1 to 2.5	NA	YES	1.5	2.5	1.5
Zinc	4/5	35.8	80.6 to 445	NA	YES	211	445	211
PAL FILTERED METALS (µg/L)								
Arsenic	5/5	NA	3.7 to 53.4	4.4	YES	20.0	53.4	20.0
Barium	5/5	NA	5.2 to 22.8	11.9	YES	13.4	22.8	13.4
Manganese	2/2	NA	37.6 to 155	107	YES	96.3	155	96.3
PAL SEMIVOLATILE ORGANICS (µg/L)								
Benzo[k]fluoranthene	1/4	0.87	0.94	NA	YES	0.56	0.94	0.56
PAL VOLATILE ORGANICS (µg/L)								
Carbon Disulfide	1/5	0.50	0.58	NA	YES	0.32	0.58	0.32
Chlorobenzene	1/5	0.50	4.6	NA	YES	1.1	4.6	1.1
Toluene	2/5	0.50	0.59 to 1.6	NA	YES	0.59	1.6	0.59
EPH/VPH (µg/L)								
Eph C11-C22 Aromatics	5/5	NA	300 to 650	NA	NA	430		
Eph C19-C36 Aliphatics	2/5	500 to 530	1,000 to 1,100	NA	NA	570		
Vph C9-C10 Aromatics	1/5	20	25	NA	NA	13		
OTHER (µg/L) Total Suspended Solids	5/5	NA	3,240,000 to 15,800,000	39,800	NA	6,620,000		

Notes:

1 Sample locations include: 57W-98-04X through 57W-98-08X (duplicate at 57W-98-07X). Filtered samples were collected at 57W-98-04X through 57W-98-08X.

2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

4 The arithmetic mean of inorganic concentrations detected in upgradient samples was used to screen surface water CPCs. Upgradient sample locations include

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SURFACE WATER¹

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

57W-95-03X and -08X.

5 Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

6 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

7 Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

8 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

9 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

10 Maximum concentration is less than the average upgradient concentration.

µg/L = micrograms per liter

AOC = Area of contamination.

CPC = Contaminant of potential concern.

NA = Not available.

PAL = Project analyte list.

RME = Reasonable maximum exposure.

SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SEDIMENT¹

AOC 57

ANALYTE	Frequency of	Range of	Range of Detected	Upgradient Sediment	Elevate Sediment	i Analyte	Average of all	Exposu Concen	re Point trations
	Detection	SQLB	Concentrations	Concentration ::::::	oncentration 3	CPC?	Concentrations	RME	Average
PAL METALS (µg/g)	eic	MA	7 710 to 15 000	12 /00	NA	VES	11 600	15 900	11 600
Aluminum	0/0	NA NA	10 4 to 220	110	25-50	YES	70.2	220	70.2
Arsenic	6/0	52	30 to 159	101	NA	YES	69.8	159	69.8
Codmium	1/6	0.70	23	NA	5-14	NO ¹⁰			
	0/0	814	0.170 to 10.400	0.000	NA	NO 11			
Calcium	6/6	NA 4.4	2,170 10 10,400	9,090	30-70	VES	23.2	48.0	23.2
Chromium	3/0	4.1	40.9 10 40.9 60 to 259	91.2	50-70 NA	VES	15.0	25.8	15.0
Cobait	5/6	1.4	0.9 10 20.0 9 7 to 201	21.2	70-130	VES	15.0	20.0	46.6
Copper	6/9 6/9	0.97	5 290 to 20 400	26,000	30 000-60 000	VES	21 300	30 400	21 300
Iron	6/6	INA 10 F		20,900	200,000-00,000	VES	176	30,400 /10	21,000
Lead	8/9	10.5	43.9 10 410	208	200-410	103		410	1/3
Magnesium	6/6	NA	1,380 to 4,480	3,710	NA	NO 11			
Manganese	9/9	NA	40.1 to 3,940	1,510	350-850	YES	1,200	3,940	1,200
Mercury	1/6	0.050	0.36	0.20	0.35-0.75	YES	0.081	0.36	0.081
Nickel	5/6	1.7	25.7 to 42.9	34.8	35-75	YES	29.3	42.9	29.3
Potocsium	4/6	100	769 to 1.240	934	NA	NO ¹¹			
Solonium	6/0	0.25	0.93 to 7.7	2.8	NA	YES	2.3	7.7	2.3
Selenium	0/5	0.20		1.150		NO 11			
Sodium	6/6	NA	741 to 3,610	1,150	NA	NO			
Vanadium	4/6	3.4	28.4 to 40.3	34.7	60-100	NO "			
Zinc	6/9	8.0	129 to 468	315	250-450	YES	206	468	206
PESTICIDES/PCBs (ug/g)									
4.4'-DDD	7/9	0.0083	0.0258 to 0.44	0.53	NA	YES	0.15	0.44	0.15
4.4-DDE	4/9	0.0077	0.086 to 0.16	0.18	NA	YES	0.056	0.16	0.056
4 4'-DDT	4/6	0.0071	0.0363 to 0.076	0.092	NA	YES	0.040	0.076	0.040
Aroclor-1260	1/9	0.0804	0,30	NA	NA	YES	0.069	0.30	0.069
Dieldrin	2/9	0.0063	0.0183 to 0.046	NA	NA	YES	0.0096	0.046	0.0096
PAL SEMIVOLATILE ORGANICS (units)									
Benzolkifuoranthene	3/9	0.066 to 1.0	0.35 to 3.0	1.8	NA	YES	0.58	3.0	0.58
Chrysene	2/9	0.12 to 2.0	0.53 to 1.2	NA	NA	YES	0.47	1.2	0.47
Fluoranthene	7/9	0.30 to 1.0	0.82 to 6.0	5	NA	YES	2.2	6.0	2.2
Phenanthrene	6/9	0.20 to 0.70	0.48 to 3.0	2.3	NA	YES	0.80	3.0	0.80
Pyrene	8/9	0.70	0.72 to 6.0	4.8	NA	YES	2.3	6.0	2.3
PAL VOLATILE ORGANICS (up/o)									
Acetone	4/9	0.017	0.071 to 0.31	0.55	NA	YES	0.080	0.31	0.080
Methylene chloride	1/9	0.012	0.15	NĂ	NA	YES	0.022	0.15	0.022
Tetrachloroethere	2/9	0.00080	0.010 to 0.078	NA	NA	YES	0.010	0.078	0.010
Tolueno	4/9	0.00080	0.0065 to 0.020	NA	NA	YES	0.0050	0.020	0.0050
Trichloroethylene	1/9	0.0028	0.027	NA	NA	YES	0.0042	0.027	0.0042
Trichlorofluoromethane	2/9	0.0059	0.020 to 0.076	NA	NA	YES	0.013	0.076	0.013



SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 SEDIMENT⁴

AOC 57

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ANALYTE	Frequency of	Rangeof	Range of Detected	Upgradient Sediment Se	Elevated diment	i Analyte	Average pf.all	Exposure Concentr	Point ations
	Detection ²	SQLs	Concentrations	Concentration Conc	entration	a CPC?	Concentrations	RME	Average
TPH BY GC (µg/g) Diesel Fuel Total Petroleum Hydrocarbons, Gas Fraction	5/6 3/6	8 8	53 to 170 107 to 150	46 57	NA NA	YES YES	78 64	170 150	78 64
OTHER (μg/g) Total Organic Carbon Total Petroleum Hydrocarbons (418.1) Total Petroleum Hydrocarbons (IR)	9/9 7/9 1/3	NA 28 1,800 to 31,000	84,900 to 602,000 103 to 3,200 2,500	277,000 240 NA	NA NA NA	NA YES YES	257,000 790 6,300	3,200 2,500	790 2,500

Notes:

¹ Sample locations include: 57D-95-04X through 57D-95-07X, 57D-95-09X, 57D-95-10X, and 57D-98-01X through 57D-98-03X.

² Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

³ Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

⁴ The arithmetic mean of concentrations detected in upgradient samples was used to screen sediment CPCs (inorganics only). Upgradient sample locations include 57D-95-03X and -08X.

⁵ Rojko, 1990. "Proposed Classification Scheme for Sediments in Massachusetts Lakes and Ponds". Values less than the provided range are classified as "normal", and values greater than the provided range are classified as "highly elevated".

⁶ Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

⁷ The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

⁸ Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calucated because there are fewer than 10 samples in the data set.

⁹ Average Exposure Point Concentrations (EPCs) are equal to the lesser of the average of all concentrations and RME.

¹⁰ Maximum concentration corresponds to a level classified as "normal" for lake sediment concentrations for this analyte (Rojko, 1990).

¹¹ Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

μg/g = micrograms per gram AOC = Area of contamination. CPC = Contaminant of potential concern. NA = Not available. PAL = Project analyte list. RME = Reasonable maximum exposure. SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SEDIMENT¹

AOC 57

	Frequency		Range of	Upgradient	Elevated		Average	Expos	ure Point
ANALYTE	of	Range of	Detected	Sediment	Seciment	Alialyte	Or will	DMC 4	Augenda *
	Defection	SQLS	Concentrations	Seconcentration:	CONCERNIACON ::::			<u></u>	
PAL METALS (pg/g)	EIE	NΔ	3.2 to 37.1	110	25-50	NO ¹⁰			
Arsenic	5/5	180	16 1 to 50 8	101	NA	NO 10			
Barium	5/5	NA NA	10.1 10 55.0	101	70 420	NO 10,11			
Copper	3/5	0.97	2.7 to 11.2	30.7	70-130	NO 10 11		-	
Lead	2/5	10.5	33.6 to 64.6	208	200-410	NO			
Manganese	5/5	NA	29 to 459	1,510	350-850	NO			
Selenium	4/5	0.25	0.72 to 1.8	2.8	NA	NO 10			
Zinc	1/5	8.0	90.8	315	250-450	NO ^{10,11}			
PESTICIDES/PCBs (µg/g)									
4,4'-DDD	3/5	0.0083	0.048 to 0.15	0.53	NA	YES	0.053	0.15	0.053
Aroclor-1260	1/5	0.080	0.84	NA	NA	YES	0.20	0.84	0.20
PAL SEMIVOLATILE ORGANICS (ug/g)									
1.2-Dichlorobenzene	1/5	0.11	0.39	NA	NA	YES	0.12	0.39	0.12
1.4-Dichlorobenzene	2/5	0.098	0.43 to 1.0	NA	NA	YES	0.32	1.0	0.32
Benzo[b]fluoranthene	1/5	0.21	0.49	NA	NA	YES	0.18	0.49	0.18
Benzo[k]fluoranthene	3/5	0.066	0.19 to 0.28	1.8	NA	YES	0.15	0.28	0.15
Chrysene	1/5	0,12	0.34	NA	NA	YES	0.12	0.34	0.12
Fluoranthene	4/5	0.068	0.17 to 0.65	5	NA	YES	0.35	0.05	0.30
Naphthalene	2/5	0.037	0.13 to 0.53	NA	NA	YES	0.14	0.53	0.14
Phenanthrene	4/5	0.033	0.085 to 0.37	2.3	NA	YES	0.19	0.37	0.19
Pyrene	5/5	NA	0.16 to 0.56	4.8	NA	TE5	0.30	0.50	0.30
PAL VOLATILE ORGANICS (µg/g)									0.45
Acetone	5/5	NA	0.057 to 0.21	0.55	NA	YES	0.15	0.21	0.15
Benzene	2/5	0.0015	0.007 to 0.037	NA	NA	YES	0.0093	0.037	0.0093
Chlorobenzene	3/5	0.0009	0.0031 to 0.019	NA	NA	YES	0.0072	0.019	0.0072
Toluene	3/5	0.0008	0.0018 to 0.0048	NA	NA	YES	0.0024	0.0046	0.0024
Xylenes	1/5	0.0015	0.011	NA	NA	TES	0.0028	0.011	0.0020
EPH/VPH (µg/g)									
EPH C11-C22 Aromatics	1/5	50 to 160	280	NA	NA	NA	90	280	90
EPH C19-C36 Aliphatics	1/5	50 to 160	630	NA	NA	NA	160	630	160
Total Petroleum Hydrocarbons	2/5	380 to 1,500	5,500	NA	NA	NA	2,400	5,500	2400
VPH C5-C8 Aliphatics	1/5	1.8 to 8.0	3.3	NA	NA	NA	2.1	3.3	2,1
VPH C9-C10 Aromatics	1/5	1.8 to 8.0	4.3	NA	NA	NA NA	2.3	4.3	2.3
VPH C9-C10 Aliphatics	2/5	1.8 to 8.0	4.2 to 5.6	NA	NA	NA	3.2	0,0	3.2
OTHER (µg/g)									
Total Organic Carbon	5/5	NA	38,400 to 210,000	NA	NA	NA	97,000		

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 SEDIMENT¹

AOC 57

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ΔΝΑLΥΤΕ	Frequency of	Range of	Range of Detected	Uppradient Sediment	Elevated Sediment	Analyte	Average of all	Exposure Point Concentrations
	Detection ²	SQLs	Concentrations	Concentration 4	Concentration ⁶	a CPC? *	Concentrations ⁷	RME Average
Total Petroleum Hydrocarbons	5/5	NA	109 to 3,500	238	NA	YES	850	3,500 850

Notes:

1 Sample locations include: 57D-98-04X through 57D-98-08X.

2 Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

3 Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

4 The arithmetic mean of inorganic concentrations detected in upgradient samples was used to screen sediment CPCs. Upgradient sample locations include 57D-95-03X and -08X.

5 Rojko, 1990. "Proposed Classification Scheme for Sediments in Massachusetts Lakes and Ponds". Values less than the provided range are classified as "normal", and values greater than the provided range are classified as "highly elevated".

6 Contaminant of Potential Concern (CPC) for aquatic and wildlife receptors.

7 The average of all concentrations assigns a value of 1/2 the SQL to all non-detects.

8 Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calucated because there are fewer than 10 samples in the data set.

9 Average Exposure Point Concentrations (EPCs) are equal to the average of all concentrations. If the average is greater than the RME, then the RME was used instead.

10 Maximum concentration is less than upgradient concentration.

11 Maximum concentration corresponds to a level classified as "normal" for lake sediment concentrations for this analyte (Rojko, 1990).

12 Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

μg/g = micrograms per gram AOC = Area of contamination. CPC = Contaminant of potential concern. NA = Not available. PAL = Project analyte list. RME = Reasonable maximum exposure. SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 GROUNDWATER ¹

AOC 57

ANALYTE	Frequency	Range of	Ratige of Detected	Background Groundwater	Upgradient Groundwater	Analyte	Average of all	Exposu Concent	e Point rations
	Detection ²	SQLs ³	Concentrations	Concentration *	Concentration ⁹	a CPC? ⁵	Concentrations	RME ³	Average 9
PAL UNFILTERED METALS (µg/L)		arthesian (, , ,							
Aluminum	3/7	141	204 to 2,480	6,870	507	NO ¹⁰		<i>.</i>	
Arsenic	3/8	2.5	4.9 to 54.4	10.5	3.6	YES	9.3	54.4 62.5	9.3 18 9
Barium	8/8	NA	7.3 to 53.5	39.0	21.3	165	10.3	03.5	10.0
Calcium	7/7		2,660 to 17,400	14,700	10,000	NU "	64	39.1	64
Copper	2/8	5 10 6.1	10.3 10 39.1	0.09	J.J 665	NO ¹⁰	F.U	QQ, I	0.4
Iron	5/7	38.8	87.4 to 0,310	9,100	1.9	YES	4.0	16.0	4.0
Lead	6/7	500	522 to 1.010	3 480	880	NO ^{10,11}			
Magnesium	0/7 7/7	500 NA	5.8 to 3.700	291	61.9	YES	593	3,700	593
Rotossium	7/7	NA	704 to 4 140	2.370	1.830	NO 11			
	777	NA	2 800 to 34 000	10,800	27 000	NO ¹¹			
Soaium Zinc	2/8	21.1 to 35.8	25.3 to 31.0	21.1	15.3	YES	13.7	31.0	13.7
Lino									
PAL FILTERED METALS (µg/L)									
Aluminum	1/7	141	167	6,870	ND	NO ¹⁰			
Arsenic	2/8	2.5	2.8 to 73.0	10.5	ND 84.6	YES	10.5	73.0	10.5
Barium	8/8	NA	7.6 to 45.6	39.0	21.0	10.10	17.4	40,0	17.4
Calcium	7/7	NA	2,590 to 14,100	14,700	11,300	NO 10,			
Iron	3/7	38.8	47.4 to 3,530	9,100	22.7	NO 1º	10	0.0	1.6
Lead	2/8	1.3	4.4 to 9.0	4.25	0.68	1 ES	1.0	9.0	1.0
Magnesium	6/7	500	507 to 1,500	3,480	887	NO "CIT	474	2 420	171
Manganese	717	NA	6.0 to 2,420	291	10.0	160	4/4	2,420	474
Potassium	7/7	NA	775 to 2,990	2,370	1,900	NO 11			
Sodium	7/7	NA	2,760 to 34,500	10,800	33,400	NO ''			
PESTICIDES (ug/L)									
Endosulfan II	1/8	0.023	0.027	NA	ND	YES	0.013	0.027	0.013
	、								
PAL SEMIVOLATILE ORGANICS (µg/L Bis(2-ethylbeyyl)nbthalate	.) 4/8	4.8	5 to 400	NA	3.4	YES	47	400	47
Diethylphthalate	1/8	2	2.7	NA	1.6	YES	1.1	2.7	1.1
1.2-Dichloroethylenes (cis and trans)	2/8	0.5	1.8 to 13	NA	ND	YES	2.2	13	2.2
Acetone	1/8	13	19	NA	ND	YES	7.3	19	7.3
Tetrachloroethylene	2/8	1.6	1.7 to 16	NA	ND	YES	2.2	16	2.2
Toluene	6/8	0.5	0.53 to 1.2	NA	0.34	YES	0.45	1.2	0.45

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 2 GROUNDWATER ¹

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency		Range of	Background	Upgradient		Average	Exposur	e Point
ANALYTE	of F Detection ²	cange of SQLs ¹	Concentrations	Groundwater	Concentration ⁵	a CPC? ⁵	Concentrations /	RME	Average ⁹
Trichloroethylene	3/8	0.5	0.71 to 1.9	NA	0.28	YES	0.63	1.9	0.63
WET CHEMISTRY (µg/L)									
Alkalinity	7/7	NA	5,330 to 224,000	NA	11,700	NA			
Chloride	7/7	NA	4,060 to 63,000	NA	53,100	NA			
Nitrite, Nitrate-non Specific	7/7	NA	32.3 to 2,000	NA	1,460	NA			
Nitrogen By Kieldahl Method	3/7	183	181 to 514	NA	121	NA			
Phosphate	5/7	13.3	13.8 to 28.5	NA	39.3	NA			
Sulfate	6/7	10.000	10,000 to 25,000	NA	11,400	NA			
Total Dissolved Solids	7/7	NA	25,000 to 174,000	NA	123,000	NA	80,600		
Total Hardness	7/7	NA	2,000 to 52,000	NA	31,900	NA	18,200		
Total Suspended Solids	8/8	NA	4,000 to 110,000	NA	30,300	NA	21,400		

Notes:

¹ Sample locations include: 57M-95-04A, 57M-95-04B, 57M-95-05X through -07X, 57M-95-08A, 57M-95-08B, and 57P-98-02X. Two rounds of samples were collected from all wells except 57P-98-02X.

² Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

³ Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

⁴ 95th percentiles of inorganic background concentrations from the Ft. Devens background groundwater database (developed in 1993) were used to screen CPCs.

⁵ Average upgradient groundwater concentration from monitoring wells 57M-95-01X, 57M-95-02X, G3M-92-02X, and G3M-92-07X.

⁶ Contaminant of Potential Concern (CPC) for aquatic receptors.

⁷ The average of all concentrations assigns a value of 1/2 the SQL to all non-detects. A temporal average was calculated for each well with more than one round of samples prior to calculating the average of all concentrations.

⁸ Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

⁹ Average Exposure Point Concentrations (EPCs) are equal to the lesser of the average of all concentrations and the RME.

¹⁰ Maximum concentration is less than the background concentration.

¹¹ Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

µg/L = micrograms per liter

AOC = Area of contamination.

CPC = Contaminant of potential concern.

NA = Not available.

ND = Not detected.

PAL = Project analyte list.

RME = Reasonable maximum exposure.

SQL = Sample quantitation limit.

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 GROUNDWATER¹

AOC 57

ANALYTE	Frequency	Range of	Range of Defected	Background Groundwater	Upgradient Groundwater	Analyte	Average of all	Exposu Concen	te Point trations
PALLINEIL TERED METALS (Junit)	Detection	5QLS	Concentrations	: Concentration: Concentration	Concentianous:		Concentrations of	<u>io museedo</u>	Several asses
Aluminum	515	141	65.2 to 2.450	6.870	507	NO ¹⁰			
Arsenic	6/7	2.54	3.73 to 170	10.5	3.6	YES	33.7	170	33.7
Barium	7/7	NA	8.4 to 87.2	39.6	21.3	YES	27.1	87.2	27.1
Cadmium	1/5	3.01 to 4.01	8.7	4.01	ND	YES	2.0	8.7	2.0
Calcium	5/5	NA	2,020 to 18,200	14,700	10,000	NO ¹¹			
Copper	1/7	5 to 8.09	8.5	8.09	5.6	YES	3.2	8.5	3.2
Iron	5/5	NA	105 to 26,500	9,100	665 ND	YES	8,000	20,000	0,000
Lead	3/7	1 to 1.26	1.85 10 8.1	4,25	ND	100	1.5	0.1	1.0
Magnesium	3/5	1,000	715 to 1,190	3,480	880	NO """	630	2 400	629
Manganese	5/5	NA	126 to 2,100	291	61.9	TEO	020	2,100	030
Potassium	4/5	1,000	1,650 to 2,500	2,370	1,830	NO "			
Sodium	4/5	2,290	1,650 to 5,050	10,800	27,000	NO 10,11,12			
Zinc	2/7	21.1 to 35.8	37.2 to 192	21.1	15.3	YES	26.7	192	26.7
				•					
PAL FILTERED METALS (µg/L)	414	NA	127 to 133	10.5	NA	YES	55.3	133	55.3
Arsenic	4/4	NA.	12.1 10 133	10.0	01.6	NO 10			
Barium	4/4	NA	6.4 to 37.4	39.0	21.0	NO 10			
Calcium	1/1	NA	9,820 to 18,600	14,700	11,300	NO **	44.000	47 500	14 200
Iron	1/1	NA	10,600 to 17,500	9,100	NA	TES	14,200	17,500	14,200
Lead	1/4	1.26 to 50	2.4	4.25	NA	NO 19			
Magnesium	1/1	NA	712 to 846	3,480	724	NO 10,11			
Manganese	1/1	NA	343 to 699	291	10.7	YES	523	699	523
Potassium	1/1	NA	1,860 to 2,970	2,370	2,030	NO ¹⁰			
Sodium	1/1	NA	1.910 to 2.190	10,800	30,300	NO 10,11,12			
Zinc	1/4	21.1 to 35.8	43.3 to 46.3	21.1	NA	YES	20.3	46.3	20.3
20									
PAL SEMIVOLATILE ORGANICS (µ	g/L)				514	VER		0.0	26
1,2-Dichlorobenzene	3/7	1.7	2.6 to 9.8	NA NA	NA NΔ	VES	14	5.6	1.4
1,4-Dichlorobenzene	2/7	1./	2.7 10 5.0	NA NA	NA	YES	1.2	4.4	1.2
2-Methylnaphtnalene	211	0.52 to 1	15 to 5	NA	NA	YES	1.0	5	1.0
4-weavyphenor Bis/2-ethylbeyyl)ohthalate	417	4.8 to 10	5.8 to 300	NA	3.36	YES	17	300	17
Nanhthalene	3/7	0.5	2.5 to 20	NA	NA	YES	4.5	20	4.5
PAL VOLATILE ORGANICS (µg/L)					1.14	VEC	0.00	0.00	0.20
1,2-Dichloroethylenes (cis and trans)	1/7	0.5	0.74 to 0.89	NA	NA NA	TEO	0.29	0.09	0.29
Carbon tetrachloride	1/7	0.58	4.5	NA NA	INA NA	YES	0.34	0.88	0.34
Chlorobenzene	1//	0.0 0.5	10	NA	0.26	YES	0.64	10	0.64
Enlorororm	4/7	0.5	1.9 to 47	NA	NA	YES	7.3	47	7.3

TABLE -----

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN AREA 3 GROUNDWATER ¹

AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	Frequency	Panoo of	Range of	Background	Upgradient Groundwater	Analyte	Average	Exposur	e Point
ANALITE	Detection ²	SQLs ³	Concentrations	Concentration	Concentration	a CPC? ⁶	Concentrations	RME *	Average
Methylene chloride	1/7	2.3	2.9	NA	NA	YES	1.4	2.9	1.4
Styrene	1/7	0.5	8	NA	NA	YES	1.4	8	1.4
Tetrachloroethvlene	2/7	1.6	2.6 to 5.5	NA	NA	YES	1.7	5.5	1.7
Toluene	4/7	0.5	0.67 to 49	NA	0.34	YES	3.5	49	3.5
Trichloroethylene	2/7	0.5	0.59 to 3.8	NA	0.28	YES	0.61	3.8	0.61
Xylenes	3/7	0.84	5.7 to 200	NA	NA	YES	21	200	21
WET CHEMISTRY (µg/L)							4		
Alkalinity	1/1	NA	38,000 to 56,000	NA	11,700	NA	47,100		
Chloride	1/1	NA	3,510	NA	53,100	NA	2,290		
Nitrite, Nitrate-non Specific	4/5	10	17.1 to 1,100	NA	1,460	NA	142		
Nitrogen By Kjeldahl Method	2/5	183	324 to 733	NA	121	NA	230		
Phosphate	3/5	13.3	16.2 to 240	NA	39.3	NA	45.3		
Total Dissolved Solids	5/5	NA	26,000 to 93,000	NA	123,000	NA	65,300		
Total Hardness	5/5	NA	10,800 to 1,660,000	NA	31,900	NA	321,000		
Total Petroleum Hydrocarbons	1/5	192 to 169,000	337	NA	16,800	NA	67,100		
Total Suspended Solids	6/7	4,000	4,000 to 2,120,000	NA	30,300	NA	238,000		

Notes:

¹ Sample locations include: 57M-95-03X (three rounds of data, plus one duplicate), 57M-96-10X through 57M-96-13X (two rounds of data for 57M-96-11X, plus two duplicates), 57P-98-03X, and 57P-98-04X. Filtered samples were collected at 57M-95-03X (two rounds, plus one duplicate), 57M-96-11X, 57P-98-03X, and 57P-98-04X.

² Frequency of Detection is equal to the number of samples in which the analyte is detected in relation to the total number of samples analyzed.

³ Sample Quantitation Limits (SQLs) are equal to the detection limit adjusted for percent moisture (solid media only) and dilutions (if any are performed).

⁴ 95th percentiles of inorganic background concentrations from the Ft. Devens background groundwater database (developed in 1993) were used to screen CPCs.

⁵ Average upgradient groundwater concentration from monitoring wells 57M-95-01X, 57M-95-02X, 57M-96-09X, G3M-92-02X, and G3M-92-07X.

⁶ Contaminant of Potential Concern (CPC) for aquatic receptors.

⁷ The average of all concentrations assigns a value of 1/2 the SQL to all non-detects. A temporal average was calculated for each well with more than one round of samples prior to calculating the average of all concentrations.

⁸ Reasonable Maximum Exposure (RME) concentrations are equal to the maximum detected concentration; the 95th percent UCL was not calculated because there are fewer than 10 samples in the data set.

⁹ Average Exposure Point Concentrations (EPCs) are equal to the lesser of the average of all concentrations and the RME.

¹⁰ Maximum concentration is less than the background concentration.

¹¹ Analyte is an essential nutrient, and is not considered toxic except at high concentrations.

¹² Maximum detected concentration is less than the upgradient concentration.

 μ g/L = micrograms per liter AOC = Area of contamination.

- CPC = Contaminant of potential concern.
- NA = Not available.

ND = Not detected.

PAL = Project analyte list.

RME = Reasonable maximum exposure.

SQL = Sample quantitation limit.

TABLE 9-56 ECOLOGICAL RECEPTORS EVALUATED AT AOC 57

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Method of Evaluation	Receptor Ev	valuated	Media						
	Common Name	Scientific Name		Surface Soil		Surface Water	Sediment		
			Upland	Floodplain	Area 3				
Food-web modeling	White-footed mouse	Peromyscus leucopus	V	4	V				
	Short-tailed shrew	Blarina brevicauda		4					
	Muskrat	Ondatra zibethicus				4	4		
	American robin	Turdus migratorius	4	V	A				
	Mallard	Anas platyrhynchos				4	4		
	Red fox	Vulpes vulpes	\checkmark		\checkmark				
	Raccoon	Procyon lotor		\checkmark		\checkmark	4		
	Barred owl	Strix varia	\checkmark	\checkmark	\checkmark				
	Great blue heron	Ardea herodias				\checkmark	\checkmark		
Benchmark Comparison	Terrestrial Plants		V	\checkmark	4				
	Soil Invertebrates		\checkmark	\checkmark	\checkmark				
	Aquatic Plants					\checkmark	\checkmark		
	Benthic Invertebrates					V	\checkmark		
	Amphibians					\checkmark	4		
	Small Fish					\checkmark	\checkmark		
Toxicity Testing	Midge	Chironomus tentans					~		
	Amphipod	Hyalella azteca					\checkmark		

TABLE 9-58 ESTIMATION OF BIOACCUMULATION AND BIOCONCENTRATION FACTORS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Receptor	r Group	Nature of Approach #	General Approach
Terrestr	ial Receptors		
Plants Unit:	mg/kg wet tissue per mg/kg dry soil	Literature Values	When available, literature values were used to estimate plant BAFs.
		SAR	When literature values were not available, plant BAFs for semivolatile organic compounds (SVOCs) were calculated using a regression equation based on the uptake of organic chemicals into plant tissue from Travis and Arms (1988). ¹
		Extrapolation and Empirical Data	When literature values were not available, plant BAFs for inorganic compounds were obtained from Baes et al. (1984). ²
		Assumption	Although evidence suggests that plants may transport organic analytes with log $K_{ows} < 5$ (i.e., volatile organic compounds [VOCs]) from the roots into leafy portions (Briggs <i>et al.</i> , 1982; Briggs <i>et al.</i> , 1983), bioaccumulation data for VOCs is generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log $K_{ows} < 3.5$ are not bioaccumulated into animal tissue. Therefore, it was assumed that transfer of VOCs from plant tissue to animal tissue does not occur.
Terrestr	ial Invertebrates		
Unit:	mg/kg wet tissue per mg/kg dry soil	Site-specific Data and Literature Values	Invertebrate BAFs were calculated based on tissue concentrations of freshwater oligochaetes (<i>Lumbriculus variegatus</i>) exposed to AOC 57 sediment (Appendix O-1, Table O-1.3). Because of uncertainties associated with the results, these calculated BAFs were not used to quantitatively evaluate wildlife exposures to invertebrate tissue. Literature values were the primary means for evaluating invertebrate bioaccumulation from soil at AOC 57.
		Assumption	Literature-derived earthworm data were used to represent all invertebrates.
		Empirical Data and As- sumption	A single BAF for PAHs was calculated using data presented in Beyer (1990); dry weight was converted to wet weight assuming earthworms are 80 percent water.
		Surrogate Values	When no literature values for invertebrates were available, mammals values were used as a surrogate.
		Assumption	Bioaccumulation data for VOCs is generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log $K_{ows} < 3.5$ are not bioaccumulated into animal tissue. Therefore, it was assumed that soil invertebrates do not bioaccumulate VOCs.
See note:	s at end of table	······································	

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TABLE 9-58 ESTIMATION OF BIOACCUMULATION AND BIOCONCENTRATION FACTORS AOC 57

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Receptor	Group	Nature of Approach	General Approach
Small Mar Unit:	mmals mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small mammals.
		SAR	When literature values were not available for SVOCs, BAFs for small mammals were estimated using a regression equation based on the uptake of organic chemicals into beef tissue from Travis and Arms (1988) ³ .
		Extrapolation/ Empirical Data	When literature values were not available, BAFs for small mammals for inorganics were derived from ingestion-to-beef biotransfer factors (BTFs) presented in Baes et al. (1984) ⁴ .
		Assumption	Bioaccumulation data for VOCs are generally lacking in the scientific literature. In addition, evidence in the literature (Suter, 1993; Maughan, 1993) suggests that analytes with log $K_{ows} < 3.5$ are not bioaccumulated into animal tissue. Therefore, it was assumed that small mammals do not bioaccumulate VOCs.
Small Bird Unit:	ds mg/kg wet tissue per mg/kg wet food	Literature Values	When available, literature values were used to estimate BAFs for small birds.
		Surrogate Values	BAFs were not available for many SVOCs or inorganic compounds as there is little bioaccumulation data available for birds. In these situations, mammal data were used as a surrogate. It was assumed that small birds do not accumulate VOCs.
Semi-aqua	atic Receptors		
<u>Surface W</u> Unit:	<u>ater</u> mg/kg tissue per mg/l water	Empirical Data	When available, BCF data were obtained from the AQUIRE database and from AWQC documents. BCF values were obtained by calculating the geometric mean of the combined BCF data (presented in Appendix O-1, Table O.1-4).
		Literature Values	When empirical data were not available, literature values for BCFs were obtained.
		SAR	When empirical or literature values were not available, BCFs were estimated using a regression equation based on the uptake of organic chemicals into fish tissue from Barnthouse et al., $(1988)^{5}$.
		Conservative As- sumption	Analytes with BCFs <300 were not considered in the surface water ingestion model (USEPA, 1989).
<u>Semi-aqu</u>	atic Receptors (Cont.)		
<u>Sediment</u> Unit:	mg/kg wet tissue per mg/kg wet sediment	Site-specific Data	As previously mentioned, aquatic invertebrate BAFs were calculated using tissue concentrations of freshwater oligochaetes (<i>Lumbriculus</i> <i>variegatus</i>) exposed to AOC 57 sediment (Appendix O-1, Table O.1-3). However, these data were not used in food web models due to uncertainties associated with the results.
			Site-specific crayfish and small fish tissue data were used directly in food web models to evaluate semi-aquatic wildlife exposures.
		Literature Values	When no site-specific information was available, literature values were used to estimate BAFs for aquatic plants and invertebrates. When literature values were not available, terrestrial plant and invertebrate BAFs were used instead.

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TABLE 9-58 ESTIMATION OF BIOACCUMULATION AND BIOCONCENTRATION FACTORS AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

 $^1\,$ Plant BAFs calculated using the following Travis and Arms (1988) regression: log BAF = 1.588 - 0.578 log K $_{ow}$.

² BAFs derived from Baes et al. (1984). Values are based on analysis of literature references, correlations with other chemical and physical parameters, or comparisons of observed and predicted elemental concentrations in vegetative and reproductive plant material and soil. Data are based on dry weight and were converted to a fresh weight basis assuming that plants are 80 percent water. This is generally consistent with the water content of berries (82 to 87 percent water) and leafy vegetables (87 to 95 percent water), presented in Suter (1993). Grains contain a much lower percentage of water (approximately 10 percent), therefore, this assumption likely underestimates exposure to graminivores.

³ Small mammal BAFs calculated using the following Travis and Arms (1988) regression: log BTF = log K ow - 7.6

where BTF = biotransfer factor (mg/kg tissue divided by mg chemical ingested per day).

- ⁴ BTFs were converted to a BAF (mg/kg tissue divided by mg/kg food) by multiplying by a food ingestion rate of 12 kg (dry weight) per day (average intake for lactating and non-lactating cattle reported in Travis and Arms, 1988).
- ⁵ Aquatic organism BCFs were calculated using the following Barnthouse et al. (1988) regression: log BCF = -0.56 + 0.96 log K ow.

Notes:

mg/kg = milligrams per kilogram

- AOC = Area of contamination.
- BAF = Bioaccumulation factor.
- BCF = Bioconcentration factor.

BTF = Biotransfer factor.

K ow = Octanol-water partition coefficient.

PAH = Polycyclic aromatic hydrocarbon.

SAR = Structure Activity Relationship.

TABLE 9-59 RESULTS OF SEDIMENT TOXICITY TESTING ¹ AOC 57

Sample location M (Chirono 10-day Subo		idge nus tentans) hronic Toxicity lest	Amı (<i>Hyalel</i> 10-day Acut	uhipod <i>la azteca</i>) e Toxicity Test	Oligochaete (<i>Lumbriculus</i> <i>variegatus</i>) 28-day Exposure Test
	Mean % Survival	Mean Weight (mg dry weight)	Mean % Survival	Mean Weight (mg dry weight)	Mean Biomass (g) /. Aquarium
Control	74 (19)	1.70 (0.32)	64 ² (18)	0.10 (0.05)	1.37 (0.09)
57D-95-04X	65 (29)	1.36 ³ (0.30)	83 (7)	0.08 (0.01)	NA
57D-95-05X	64 (29)	2.00 (0.48)	70 (19)	0.16 (0.05)	1.43 (0.11)
57D-95-06X	90 (8)	1.80 (0.19)	84 (9)	0.08 (0.03)	1.52 (0.41)
57D-95-07X	71 (24)	2.27 (0.67)	74 (7)	0.11 (0.04)	NA
57D-95-08X (Refer- ence)	84 (12)	1.81 (0.30)	80 (21)	0.10 (0.03)	1.18 (0.25)
57D-95-10X	83 (12)	1.75 (0.33)	71 (18)	0.11 (0.06)	NA

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

¹ Toxicity testing methods and results (including controls and references) are described in Appendix Q. The numbers in parentheses are the standard deviations.

² The control survival did not meet the acceptance criteria of 80%.

³ Midge growth in this sample was statistically significantly less than the reference sample (57D-95-08X).

Notes: % = percent mg = milligrams

TABLE 9-60 RESULTS OF FOOD-WEB MODELING FOR SURFACE SOIL, SEDIMENT, AND SURFACE WATER [A] AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Media Evaluated	Risk from Exposure to RME Concentrations	Risk from Exposure to Average Exposure Con-	Primary Risk Contributors	
Ecological Receptor		centrations		
Area 2 Upland Surface Soil				
White-footed mouse	1.5	0.98	Arsenic	
American robin	0.94	0.60	NA	
Red fox	0.000077	0.000045	NA	
Barred owl	0.00021	0.00013	NA	
Area 2 Floodplain Surface Soil	and a subscription of the standard state of the			
White-footed mouse	4.0	1.9	Arsenic	
Short-tailed shrew	2.4	1:0	Selenium (HQ<1), lead (HQ <1)	
American robin	1.8	0.71	Arsenic (HQ <1), Aroclor-1260 (HQ <1)	
Raccoon	0.037	0.0069	NA	
Barred owl	0.00028	0.00011	NA	
Area 3 Surface Soil	(cher: her-langerstifictive) in 1-statestics - investigation along	ార్. రోడు పేరువుదురు, విజిలిగి ఇంద్రాలు చిరార్ గార్ దారాదు 2 గారాజకులు 7 కంటా ఈ రాజకులు 3 గా		
White-footed mouse	3.0	17	Arsenic	
American robin	0.91	0.44	NA	
Red fox	0.0011	0.00030	NA	
Barred owl	0.00034	0.00017	NA	
Area 2 Sediment and <u>Unfiltered</u> Su	rface Water	a any interface of the and the second of the second second second second second second second second second sec		
Muskrat	9944	4.6	Arsenic, lead, manganese	
Mallard	0.015	0.0050	NA	
Raccoon	0.028	0.014	NA	
Great blue heron	12	6.8	Mercury	
Area 2 Sediment and <u>Filtered</u> Surfa	ice Water	1. 1. 2. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.		
Muskrat	13	4.5	Arsenic, lead, manganese	
Mallard	0.015	0.0048	NA	
Raccoon	0.020	0.0074	NA	
Great blue heron	6.1	1.8	Mercury	
Area 3 Sediment and <u>Unfiltered</u> Su	rface Water			
Raccoon	0.00054	Not evaluated	NA	
 [a] The information listed below is a all detected contaminants. NA = Not applicable. 	summary of Tables O-2.1 throug	h O-2.22 in Appendix O-2. Th	ese values are HIs calculated from	

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TABLE 9-61 SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 UPLAND SURFACE SOIL AOC 57

Analyte	Exposure Point Concentrations ¹		RT	/ (µg/g)	RTV Exceeded? ³ (by Max./by Ave.)		
	RME	Average	Plant ²	Invertebrate 2	Plant	Invertebrate	
PAL Metals (µg/g)							
Arsenic	21	14.5	10	100	Yes/Yes	No/No	
Cobalt	7.5	4.6	20	NA	No/No	NA	
Copper	15.6	11	100	30	No/No	No/No	
Manganese	481	282	500	NA	No/No	NA	
Nickel	30.7	16.8	30	400	Yes/No	No/No	
Selenium	0.88	0.28	1	NA	No/No	NA	
Pesticides/PCBs (µg/g)							
4,4'-DDE	0.020	0.0070	12.5	12	No/No	No/No	
4,4'-DDT	0.026	0.0080	12.5	12	No/No	No/No	
PAL Semivolatile Organics (µg/g)							
2-Methylnaphthalene	0.43	0.20	25	34	No/No	No/No	
Bis(2-ethylhexyl)phthalate	2.7	1.6	1,000	478	No/No	No/No	
Dibenzofuran	0.16	0.083	617	NA	No/No	NA	
Fluoranthene	0.30	0.16	25	34	No/No	No/No	
Naphthalene	0.42	0.21	100	34	No/No	No/No	
Phenanthrene	0.28	0.15	25	34	No/No	No/No	
Pyrene	0.40	0.18	25	34	No/No	No/No	
PAL Volatile Organics (µg/g)				_			
Chloroform	0.00089	0.00053	1,000	150	No/No	No/No	
Ethylbenzene	0.0024	0.0012	200	21	No/No	No/No	
Tetrachloroethylene	0.0030	0.00092	1,000	150	No/No	No/No	
Toluene	0.0037	0.0017	200	21	No/No	No/No	
Trichlorofluoromethane	0.017	0.0075	NA	NA	NA	NA	
Xylenes	0.029	0.0064	1,000	21	No/No	No/No	
Other (μg/g)						,	
Total Petroleum Hydrocarbons	8,000	1,700	NA	NA	NA	NA	
See notes at end of table							

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

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TABLE 9-61 (CONTINUED) SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 UPLAND SURFACE SOIL AOC 57

REMEDIAL INVESTIGATION REPORT **DEVENS, MASSACHUSETTS**

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 ¹ Exposure Point Concentrations (EPCs) are presented in Table 9-47.
 ² Plant and invertebrate RTVs are presented in Appendix O-1, Tables O-1.7 and O-1.8 (respectively). Generally, the plant RTVs are the lowest LOEC from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC50 (14day soil test on Eisenia foetida) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9% of the population from lethal effects (USEPA, 1986).

³ Comparison shown is maximum EPC to RTV/average EPC to RTV.

RTV = Reference toxicity value.

 μ g/g = micrograms per gram.

 LC_{50} = concentration lethal to 50% of the test population.

LOEC = lowest observed effect concentration.

NA = Not available.

RME = Reasonable maximum exposure.

Shading indicates exceedances.

TABLE 9-62 SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 FLOODPLAIN SURFACE SOIL AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations ¹		RTN	' (μg/g)	RTV Exceeded? ³ (by RME / by Avg.)		
	RME	Average	Plant ²	Invertebrate ²	Plant	Invertebrate	
PAL Metals (µg/g)							
Antimony	1.6	1.6	5	NA	No/No	NA	
Arsenic	47.9	24.1	10	100	Yes/Yes	No/No	
Barium	106	47.9	500	NA	No/No	NA	
Copper	39.3	15.6	100	30	No/No	Yes/No	
Lead	320	143	50	1,190	Yes/Yes	No/No	
Manganese	273	149	500	NA	No/No	NA	
Selenium	4.4	1.9	1	NA	Yes/Yes	NA	
Zinc	150	55.1	50	130	Yes/Yes	Yes/No	
Pesticides/PCBs (µg/g)							
4,4'-DDD	0.010	0.0071	12.5	12	No/No	No/No	
4,4'-DDE	0.034	0.013	12.5	12	No/No	No/No	
4,4'-DDT	0.18	0.039	12.5	12	No/No	No/No	
Aroclor-1260	3.6	0.63	40	NA	No/No	NA	
Dieldrin	0.025	0.0099	12.5	30	No/No	No/No	
PAL Semivolatile Organics (µg/g)							
2-Methylnaphthalene	0.38	0.18	25	34	No/No	No/No	
Acenaphthylene	0.26	0.13	25	34	No/No	No/No	
Benzo[k]fluoranthene	0.60	0.27	25	34	No/No	No/No	
Chrysene	0.71	0.39	25	34	No/No	No/No	
Di-n-butylphthalate	0.77	0.33	200	478	No/No	No/No	
Fluoranthene	2.0	0.58	25	34	No/No	No/No	
Naphthalene	0.30	0.14	100	34	No/No	No/No	
Phenanthrene	1.0	0.39	25	34	No/No	No/No	
Pyrene	2.0	0.63	25	34	No/No	No/No	
PAL Volatile Organics (µg/g)							
1,2-Dichloroethylene (cis and trans)	0.0069	0.0036	>1000	150	No/No	No/No	
Acetone	0.067	0.029	NA	NA	NA	NA	
Ethylbenzene	0.0059	0.003	200	21	No/No	No/No	
Methylene chloride	0.0081	0.0068	>1,000	150	No/No	No/No	
Tetrachloroethylene	0.0014	0.0009	>1,000	150	No/No	No/No	
Toluene	0.0051	0.0017	200	21	No/No	No/No	

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TABLE 9-62 SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 2 FLOODPLAIN SURFACE SOIL AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations ¹		RT	' (μɡ/ɡ)'	RTV Exceeded? ⁴ (by RME / by Avg.)		
	RME	Average	Plant ²	Invertebrate ²	Plant	Invertebrate	
Trichlorofluoromethane	0.0072	0.0048	NA	NA	NA	NA	
Other (µg/g)							
Total Petroleum Hydrocarbons	17,000	3,500	NA	NA	NA	NA	

¹ Exposure Point Concentrations (EPCs) are presented in Table 9-20.

² Plant and invertebrate RTVs are presented in Appendix O-1, Tables O-1.7 and O-1.8 (respectively). Generally, the plant RTVs are the lowest LOEC from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC₅₀ (14-day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9% of the population from lethal effects (USEPA, 1986).

Comparison shown is maximum EPC to RTV/average EPC to RTV.

RTV = reference toxicity value.

 $\mu g/g = micrograms per gram.$ LC₅₀ = concentration lethal to 50% of the test population. LOEC = lowest observed effect concentration. NA = Not available. RME = Reasonable maximum exposure.

Shading indicates exceedances.

TABLE 9-63 SUMMARY OF ECOLOGICAL RISK FOR PLANTS AND INVERTEBRATES IN AREA 3 SURFACE SOIL AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte	Exposure Point Concentrations ¹		RTV	ζ (μg/g)	RTV Exceeded? ³ (by RME / by Avg.)		
	RME	Average	Plant ²	Invertebrate ²	Plant	Invertebrate	
PAL Metals (µg/g)							
Arsenic	41	25.0	10	100	Yes/Yes	No/No	
Cadmium	1.5	0.93	3	50	No/No	No/No	
Manganese	548	2.19	500	NA	Yes/No	NA	
Selenium	1.6	0.48	1	NA	Yes/No	NA	
Pesticides/PCBs (µg/g)							
4,4'-DDD	0.27	0.061	12.5	12	No/No	No/No	
4,4'-DDE	0.0081	0.0081	12.5	12	No/No	No/No	
4,4'-DDT	0.025	0.014	12.5	12	No/No	No/No	
Chlordane-Alpha	0.0028	0.0021	12.5	NA	No/No	NA	
Chlordane-Gamma	0.0028	0.0021	12.5	NA	No/No	NA	
Aroclor-1260	0.47	0.12	40	NA	No/No	NA	
PAL Semivolatile Organics (µg/g)							
1,2-Dichlorobenzene	0.35	0.13	248	NA	No/No	NA	
I,4-Dichlorobenzene	0.48	0.16	248	NA	No/No	NA	
Fluoranthene	0.14	0.14	25	34	No/No	No/No	
Naphthalene	0.048	0.048	100	34	No/No	No/No	
Phenanthrene	0.11	0.11	25	34	No/No	No/No	
Pyrene	0.15	0.15	25	34	No/No	No/No	
PAL Volatile Organics (µg/g)							
Chlorobenzene	0.012	0.0033	>1,000	21	No/No	No/No	
Toluene	0.0030	0.0014	200	21	No/No	No/No	
Trichloroethylene	0.0042	0.0021	>1,000	150	No/No	No/No	
Other (µg/g)							
Total Petroleum Hydrocarbons	2,900	850	NA	NA	NA	NA	

¹ Exposure Point Concentrations (EPCs) are presented in Table 9-49.

Plant and invertebrate RTVs are presented in Appendix O-1, Tables O-1.7 and O-1.8 (respectively). Generally, the plant RTVs are the lowest LOEC from among plant growth studies on plants in solid media, and invertebrate RTVs are the lowest LC₅₀ (14day soil test on *Eisenia foetida*) from among chemicals in the same chemical class (applies to organic compounds). A conservative factor of 0.2 was applied to invertebrate RTVs; the resultant value should be protective of 99.9% of the population from lethal effects (USEPA, 1986).

³ Comparison shown is maximum EPC to RTV/average EPC to RTV.

RTV = reference toxicity value.

µg/g = micrograms per gram.

 LC_{50} = concentration lethal to 50% of the test population.

LOEC = lowest observed effect concentration.

NA = Not available.

RME = Reasonable maximum exposure.

Shading indicates exceedances.

TABLE 9-64 COMPARISON OF AREA 2 SURFACE WATER EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES ¹ AOC 57

Analyte	Exposure Point Concentrations		AWQC ² (µg/l)	AQUIRE of Amphibian Lowest Reported	Result
 Billing and the second state of t				Adverse Effect Concentration ³	The President Statistics of Header Art
				(μg/l) / Test Species	
	RME	Average			
PAL Unfiltered Metals (µg/l)	and the state of the	trafferrössjar försanden att som			
Aluminum	15,100	2,650	⁴ 87	50/narrow-mouthed frog LC50	Exceeded
Arsenic	198	50.6	190	1,700/water flea LC ₅₀	Exceeded
Barium	553	155	NA	8,900/water flea reproduction	Not exceeded
Cadmium	24,6	- 5.8	⁵ 1.1	0.32/water flea growth	Exceeded
Chromium	35.8	8.5	11	5/water flea growth, reproduction, and mortality	Exceeded
Copper	375 74.9		⁵ 12	1.5/water flea reproduction and mortality	Exceeded
Iron	17,600	5,840	1,000	3,700/duckweed growth	Exceeded
Lead	967	243	⁵ 3.2	40/narrow-mouthed toad50	Exceeded
Manganese	433	243	NA	280/phytoplankton population endpoints	Exceeded
Mercury	0.24	0.14	⁶ 0.012	1.3/narrow-mouthed toad ₅₀	Not exceeded
Selenium	2.4	1.5	5.0	70/scud LC50	
Vanadium	72.3	16.6	NA	128/guppy LC50	Not exceeded
Zinc	712	180	⁵ 110	10/narrow-mouthed toad LC50	Exceeded
PAL Filtered Metals (µg/l)	ļ				
Arsenic	8.9	5.1	190	1,700/water flea LC50	Not exceeded
Barium	43.1	18.3	NA	8,900/water flea reproduction	Not exceeded
Iron	17,200	4,540;	1,000	3,700/duckweed growth	Exceeded
Lead	2.3	1.1	⁵ 2.5	40/narrow-mouthed toadso	Not exceeded
Manganese	483.	197	NA	280/photoplankton population endpoints	Exceeded
Zinc	58.4	100000021	⁵ 108	10/narrow-mouthed toad LC50	Exceeded
PAL Semivolatile Organics (µg/l)					
Bis(2-ethylhexyl)phthalate		4.8	⁷ 160	0.89/moorfrog hatchability	Exceeded
Phenanthrene	0.52	0.28	⁷ 6.3	NA	Not Exceeded
See notes at end of table				· · ·	

TABLE 9-64 COMPARISON OF AREA 2 SURFACE WATER EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES 1 BENCHMARK VALUES 1 AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte	Exposur Concent	e Point rations	AWQC ² (µg/l)	AQUIRE of Amphibian Lowe Reported Adverse Effect Concentration ³ (µg/l) / Test-Species	st Result
	RME	Average			
PAL Volatile Organics (µg/l)					
1,2-Dichloroethylenes (cis and trans)	26	3.1	NA	¹⁰ 2,400/water flea lethality	Not exceeded
Carbon disulfide	1.1	0.34	NA	NA	No benchmark available
Chloroform	0.72	0.30	⁸ 1,240	4,160/northern leopard frog LCso	Not exceeded
Methylene chloride	4.1	1.8	NA	17,780/bullfrog teratogenesis	Not exceeded
Tetrachloroethylene	1.8	1.1	⁸ 840	510/water flea growth and reproduction	Not exceeded
Toluene	1.1	0.34	⁹ 17,500	390/northern leopard frog LC_{50}	Not exceeded
Trichloroethylene	3.5	0.65	⁸ 21,900	2,300/water flea LC50	Not exceeded
Wet Chemistry (µg/l)					
Alkalinity	36,000	30,000	> 20,000	NA	Acceptable
Chloride	100,000	50,000	230,000	NA	Not exceeded
Other (µg/l)					
Total Petroleum Hydrocar- bons	920	250	NA	NA	No benchmark available

Results of analyses of surface water samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-50 are presented.

² Chronic Federal Ambient Water Quality Criteria (USEPA, 1991 and 1988).

³ The lowest value reported in either Tables O-1.9 or 0.1-10 in Appendix O. Only growth, mortality, reproductive, and biomass effects to fish, plants, invertebrates, and amphibians were considered.

⁴ Based on a pH of 6.5-9.

⁵ Hardness dependent criterion based on an average site-specific hardness concentration of 100 mg CaCO₃. Hardness-adjusted values for unfiltered metals are from the AWQC (USEPA, 1991), and hardness-adjusted values for filtered metals are from the Ecotox Thresholds (USEPA, 1996).

⁶ Value based on the marketability of fish, which is intended to be protective of human health. Therefore, this number was not used to evaluate risk to aquatic organisms.

⁷ Proposed criterion.

⁸ Insufficient data to derive criterion; value presented is the Lowest Observed Effect Level (LOEL).

⁹ Chronic AWQC is not available; value shown is the acute AWQC.

¹⁰ Value is for 1,1-Dichloroethylene.

Notes:

CPC = contaminant of	potential concern
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= concentration exceeds the most conservative toxicity benchmark

μg/l = micrograms per liter

AWQC = Ambient Water Quality Criteria (guidance criteria established under the Clean Water Act)

NA = Not available

TABLE 9-65 COMPARISON OF AREA 3 SURFACE WATER EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES 1 BENCHMARK VALUES 1 AOC 57

Analyte	Exposure Point Concentrations		AWQC ² (µg/l)	AQUIRE Lowest Reported Adverse Effect Concentration ³ (µg/l) / Test Species	Result
	Maximum	Average			
PAL Unfiltered Metals (µg/l)					
Antimony	5.6	2.1	⁷ 30.0	NA	Not exceeded
Arsenic	153	49.1	190	1,700/water flea LC50	Not exceeded
Barium	278	176	NA	8,900/water flea reproduction	Not exceeded
Copper	44,1	23.9	⁵12	1.5/water flea reproduction and mortality	Exceeded
Lead	184	92,4	⁵ 3.2	40/narrow-mouthed toad LC50	Exceeded
Selenium	2.5	1.5	5.0	70/scud LC ₅₀	Not exceeded
Zinc	445	211	⁵ 110	10/narrow-mouthed toad LC50	Exceeded
PAL Filtered Metals (µg/l)					
Arsenic	53.4	20.0	190	1,700/water flea LC50	Not exceeded
Barium	22.8	13.4	NA	8,900/water flea reproduction	Not exceeded
Manganese	155	96.3	NA	280/photoplankton population endpoints	Not exceeded
PAL Semivolatile Organics (µ	ıg/l)				
Benzo[k]fluoranthene	0.94	0.56	NA	NA	No benchmark available
PAL Volatile Organics (µg/l)					
Carbon disulfide	0.58	0.32	NA	NA	No benchmark available
Chlorobenzene	4.6	1.1	NA	880/Goldfish LC50	Not exceeded
Toluene	1.6	0.59	⁷ 17,500	390/northern leopard frog LC50	Not exceeded

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Results of analyses of surface water samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-51 are presented.

² Chronic Federal Ambient Water Quality Criteria (USEPA, 1991 and 1988).

³ From Appendix O-1, Table O-1.9. Only growth, mortality, reproductive, and biomass effects to fish, plants, invertebrates, and amphibians were considered.

⁴ Based on a pH of 6.5-9.

⁵ Hardness dependent criterion based on an average site-specific hardness concentration of 100 mg CaCO₃.

⁶ Value based on the marketability of fish, which is intended to be protective of human health. Therefore, this number was not used to evaluate risk to aquatic organisms.

⁷ Insufficient data to derive criterion; value presented is the Lowest Observed Effect Level (LOEL).

Notes: •

CPC = contaminant of potential concern

 $\mu g/l = micrograms per liter$

AWQC = Ambient Water Quality Criteria (guidance criteria established under the Clean Water Act)

NA = Not available

COMPARISON OF AREA 2 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES ¹ AOC 57

Analyte	Exposure Concenti	Point ations	USEPA Sediment Quality Guidelines ²	AAON		NOAA ³		OME LEL ⁴	NYSDEC LEL ⁵	Result
	Maximum	Average		ER-L	ER-M			and the second second second		
PAL Metals (µg/g)										
Aluminum	15,900	11,600	NA	NA	NA	NA	NA	No benchmark available		
Arsenic	220	70,2	NA	8.2	70	6.0	6.0	Exceeded		
Barium	159	69.8	NA	NA	NA	NA	NA	6		
Chromium	48.9	23.2	NA	81	370	26	26	Exceeded		
Cobalt	25.8	15	NA	NA	NA	50	. NA	Not exceeded		
Copper	201	46.6	NA	34	270	16	16	Exceeded		
lron	30,400	21,300	NA	NA	NA	20,000	20,000	Exceeded		
Lead	410	175	NA	46.7	218	31	31	Exceeded		
Manganese	3,940	1,200	NA	NA	NA	460	460	Exceeded		
Mercury	0.36	0.081	NA	0.15	0.71	0.2	0.15	Exceeded		
Nickel	42.9	29.3	NA	20.9	51.6	16	16	Exceeded		
Selenium	7.7	2.3	NA	NA	NA	NA	NA	No benchmark available		
Zinc	468	206	NA	150	410	120	120	Exceeded		
Pesticides/PCBs (µg/g)										
4,4'-DDD	0.44	0.15	⁷ 0.213	⁷ 0.00158	⁷ 0.0461	0.008	⁷ 0.257	Exceeded		
4,4'-DDE	0.16	0.056	⁷ 0.213	0.0022	0.027	0.005	⁷ 0.257	Exceeded		
4,4'-DDT	0.076	0,040	0.213	0.00158	0.0461	0.007	0.257	Exceeded		
Pesticides/PCBs (μg/g) (Cont.)										
Aroclor-1260	0.30	0.069	⁸ 5.01	0.0227	0.180	0.005	4.96	Exceeded		

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

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TABLE 9-66

COMPARISON OF AREA 2 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES ¹ AOC 57

Analyte	Exposure Concente	Point ations	USEPA Sediment Quality Guidelines ²	NOAA ³		OME LEL ⁴	NYSDEC LEL [®]	Result
	Maximum	Average		ER-L	ER-M			
Dieldrin	0.046	0.0096	2.83	NA	NA	0.002	2.31	Exceeded
PAL Semivolatile Organics (µg/g)								
Benzo(k)fluoranthene	3:0	0.58	NA	NA	NA	0.240	NA	Exceeded
Chrysene	1.2	0.47	NA	0.384	2.8	0.34	NA	Exceeded
Fluoranthene	6.0	2.2	159.3	0.6	5.1	• 0.750	262	Exceeded
Phenanthrene	3.0	0.80	46.3	0.24	1.5	0.560	30.8	Exceeded
Pyrene	6.0	2.3	337	0.665	2.6	0.490	NA	Exceeded
PAL Volatile Organics (µg/g)								
Acetone	0.31	0.080	NA	NA	NA	NA	NA	9
Methylene chloride	0.15	0.022	NA	NA	NA	NA	NA	10
Tetrachloroethene	0.078	0.010	NA	NA	NA	NA	NA	11
Toluene	0.02	0.005	NA	NA	NA	NA	NA	12
Trichloroethylene	0.027	0.0042	NA	NA	NA	NA	NA	13
Trichlorofluoromethane	0.076	0.013	NA	NA	NA	NA	NA	No benchmark available
TPH by GC (µg/g)								
Diesel Fuel	170	78	NA	NA	NA	NA	NA	No benchmark available
TPH Gas Fraction	150	64	NA	NA	NA	NA	NA	No benchmark available
Other (mg/kg)								
ТРН	3,200	790	NA	NA	NA	NA	NA	No benchmark available

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

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TABLE 9-66

COMPARISON OF AREA 2 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES ¹ AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte Exposure Point	USEPA NOAA ³ OME LEL ⁴ NYSDEC LEL ⁵ Result	の雑様
Concentrations	Sediment Quality	Ser and
Construction of the party including the standard strength of the standard strength of the stre	Guidelines	
Maximum Average	ER-L ER-M	適な

¹ Results of analyses of sediment samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-52 are presented.

² U.S. Environmental Protection Agency (USEPA, 1988) mean Sediment Quality Criteria (SQCs) adjusted values using site-specific total organic carbon (TOC) of 25.7%. All values represent Final Chronic Values (FCVs); when no FCVs were available, Final Residue Values (FRVs) were used instead.

³ National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) Sediment Guidelines correspond to the concentration that is protective of the 90th percentile and the 50th percentile of the test populations, respectively (Long et al., 1994).

⁴ Ontario Ministry of the Environment (OME) Low Effects Level (LEL) Provincial Sediment Quality Guidelines (Persaud et al., 1996) correspond to a concentration that can be tolerated by the majority of benthic organisms.

⁵ New York State Department of Environmental Conservation (NYSDEC) sediment criteria for evaluating chronic toxicity to benthic aquatic life (NYSDEC, 1994). These values are adjusted by the average site TOC content of 25.7%. The lowest effect levels (LELs) for metals are also presented.

⁶ A sediment guideline of 20 mg/kg (provided by U.S. EPA Region V for the pollution classification of Great Lakes Harbor sediment [Fitchko, 1989]) is exceeded by the RME and average barium concentrations. These concentrations for barium fall within the range of "heavily polluted" sediments.

⁷ Value for 4,4'-DDT used as a surrogate.

⁸ Value for Aroclor-1254 used as a surrogate.

⁹ A sediment guideline of 0.064 µg/g (provided by the Oak Ridge National Laboratory for screening sediment CPCs for effects to aquatic biota [ORNL, 1994]) is exceeded by the RME and average acetone concentrations.

¹⁰ A sediment guideline of 0.427 µg/g (ORNL, 1994) is not exceeded by the RME and average concentrations of methylene chloride.

¹¹ A sediment guideline of 2.73 μg/g (ORNL, 1994) is not exceeded by the RME and average concentrations of tetrachloroethylene.

¹² A sediment guideline of 0.786 µg/g (ORNL, 1994) is not exceeded by the RME or average toluene concentration.

¹³ A sediment guideline of 1.07 μg/g (ORNL, 1994) is not exceeded by the RME or average trichloroethylene concentration.

Notes:

µg/g = micrograms per gram

NA = Not available

TABLE 9-67 COMPARISON OF AREA 3 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES ¹ AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte	Exposur Concen	e Point rations	USEPA Sediment Quality Guidelines ²	NOA	A ³	OME L- EL ⁴	NYSDEC LEL ⁵	Result
	Maxi- mum	Average		ER-L	ER-M			
Pesticides/PCBs (µg/g)	1.1.1 (A.100) // 4 /							
4,4'-DDD	0.15	0.053	⁷ 0.0803	⁷ 0.00158	⁷ 0.0461	0.008	0.097	Exceeded
Aroclor-1260	0.84	0.20	⁸ 1.89	0.0227	0.180	0.005	1.87	Exceeded
PAL Semivolatile Orga	nics (µg/g)							
1,2-Dichlorobenzene	0.39	0.12	NA	NA	NA	NA	1.16	Not exceeded
1,4-Dichlorobenzene	1.0	0.32	NA	NA	NA	NA	1.16	Not exceeded
Benzo(b)fluoranthene	0.49	0.18	NA	NA	NA	0.240	NA	Exceeded
Benzo(k)fluoranthene	0:28	0.15	NA	NA	NA	0.240	NA	Exceeded
Chrysene	0.34	0.12	NA	0.384	2.8	0.34	NA	Not exceeded
Fluoranthene	0.65	0.36	60.1	0.6	5.1	0.750	98.9	Exceeded
Naphthalene	0.53	0.14	NA	0.16	2.1	NA	NA	Exceeded
Phenanthrene	0.37	0.19	17.5	0.24	1.5	0.560	11.6	Exceeded
Ругепе	0.56	0.36	127	0.665	2.6	0.490	NA	Exceeded
PAL Volatile Organics	(µg/g)							
Acetone	0.21	. 0.15	NA	NA	NA	NA	NA	9
Benzene	0.037	0.0093	NA	NA	NA	NA	NA	10
Chlorobenzene	0.019	0.0072	NA	NA	NA	NA	0.34	Not exceeded
Toluene	0.0048	0.0024	NA	NA	NA	NA	NA	11
Xylenes	0.011	0.0028	ŇA	NA	NA	ŇA	NA	12
See notes at end of table	••••••••••••••••••••••••••••••••••••••							

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TABLE 9-67 COMPARISON OF AREA 3 SEDIMENT EXPOSURE CONCENTRATIONS WITH TOXICITY BENCHMARK VALUES ¹ AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Analyte	Exposur Concent	e Point rations	USEPA Sediment Quality Guidelines ²	NOA	A ³	OME L- EL 4	NYSDEC LEL ⁵	Result
会选。这是他们是那种 的 的时候。	Maximum	Average		ER-L	ER-M		の時間であるとない。	
Other (mg/kg)								
TPH	3,500	850	NA	NA	NA	NA	NA	No benchmark available

Results of analyses of sediment samples are included in Section 7. Only those analytes selected as aquatic CPCs in Table 9-53 are presented.

U.S. Environmental Protection Agency (USEPA, 1988) mean Sediment Quality Criteria (SQCs) adjusted values using site-specific total organic carbon 2 (TOC) of 9.7%. All values represent Final Chronic Values (FCVs); when no FCVs were available, Final Residue Values (FRVs) were used instead.

National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) Sediment Guidelines correspond to the concentration that is protective of the 90th percentile and the 50th percentile of the test populations, respectively (Long et al., 1994).

Ontario Ministry of the Environment (OME) Low Effects Level (LEL) Provincial Sediment Quality Guidelines (Persaud et al., 1996) correspond to a concentration that can be tolerated by the majority of benthic organisms.

New York State Department of Environmental Conservation (NYSDEC) sediment criteria for evaluating chronic toxicity to benthic aquatic life (NYSDEC, 1994). These values are adjusted by the average site TOC content of 9.7%. The lowest effect levels (LELs) for metals are also presented.

A sediment guideline of 20 mg/kg (provided by U.S. EPA Region V for the pollution classification of Great Lakes Harbor sediment [Fitchko, 1989]) is 6 exceeded by the RME and average barium concentrations. These concentrations for barium fall within the range of "heavily polluted" sediments.

7 Value for 4,4'-DDT used as a surrogate.

Value for Aroclor-1254 used as a surrogate.

A sediment guideline of 0.064 µg/g (provided by the Oak Ridge National Laboratory for screening sediment CPCs for effects to aquatic biota [ORNL, 9 1994]) is exceeded by the RME and average acetone concentrations.

A sediment guideline of 0.052 µg/g (ORNL, 1994) is not exceeded by the RME and average concentrations of benzene.

¹¹ A sediment guideline of 0.786 μ g/g (ORNL, 1994) is not exceeded by the maximum or average toluene concentration. ¹² A sediment guideline of 1.21 μ g/g (ORNL, 1994) is not exceeded by the maximum or average xylene concentration.

Notes:

 $\mu g/g = micrograms per gram$ NA = Not available

TABLE 9-68 POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Potential source	Direction of Effect on Risk	Justification
Uncertainties Associated with CPC Selec	tion Process	
Degradation of chemicals not considered	Overestimate	Risk estimates are based on recent chemical concentrations. Concentrations will tend to decrease over time from degradation and the formation of daughter products.
No evaluation of Tentatively Identified Compound (TIC) data	Underestimate	Risk was not calculated for potential exposure to TICs.
Use of estimated data	Unknown	Using estimated data in the risk assessment may over- or under-estimate the actual concentration of an analyte in site media.
Uncertainties Associated with Exposure	Assessment	
Surface soil sampling depths	Underestimate	Most terrestrial receptors wil be exposed only within the first six inches of soil where contaminant concentrations are typically greatest. Sampling the upper two feet of soil provides a diluted soil exposure concentration.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters are from the literature and some are estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds, so that exposure estimates would be representative of more than a single species.
Assumption that receptor species will spend equal time at all habitats within home range	Unknown	Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures.
Extrapolation of literature values from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference will vary with each chemical.
Organism-specific state variables	Underestimate	Surrogate laboratory animals are well-maintained and kept under controlled conditions. Field species must tolerate general environmental stressors that can exacerbate contaminant-induced stress.
Consumption of contaminated prey	Unknown	Toxicity to receptors may result in sickness or mortality, thus making fewer prey items available to predators. Predators may stop foraging in areas with reduced prey populations, or discriminate against, or, conversely, select contaminated prey. Furthermore, anthropogenic sources of contamination may not even have as great an impact on the predator-prey relationship as do climatic effects.
Use of surrogate values for invertebrate BAFs	Underestimate	Bioaccumulation data for earthworms are lacking for several metals (e.g., aluminum, antimony, barium, cobalt, manganese, and vanadium); therefore, mammal BAFs were used as surrogates. However, earthworms may actually bioaccumulate these metals to a greater degree than mammals.
Food chain assumed to occur at site	Unknown	Occurrence of the food chain used in the models at the sites is unknown.
Maximum exposure scenarios	Overestimate	It is unlikely any receptor would be exposed concurrently to maximum concentrations of all CPCs.

TABLE 9-68 POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Potential source	Direction of Effect on Risk	Justification
No evaluation of dermal or inhalation exposure pathways	Underestimate	The dermal and inhalation exposure pathways are generally considered insignificant due to protective fur, feathers, chitinous exoskeletons, and the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Continuous uptake and bioaccumulation of CPCs by soil biota	Unknown	Tissue and organ responses to CPC uptake are represented by a linear function which is an oversimplification of a more complex system (i.e., trophic states and lipid concentrations may affect bioaccumulation, or contaminants may only be seasonally available).
Bioaccumulation of CPCs in leafy portions of plants	Overestimate	Ryan et al. (1988) states that compounds with log $K_{ows} > 5$ are unavailable to plants due to soil sorption. Compounds with log $K_{ows} > 5$ will be taken into the roots of plants, but are not easily transported into the leafy parts of plants (Briggs et al., 1982; 1983). The surface soil ingestion exposure model overestimates CPC exposure via plant ingestion to those receptors that only eat the leafy portions of plants.
Seasonal changes in receptor foraging habits	Unknown	The food-chain model does not consider variations in a receptor's foraging habits due to seasonal changes and breeding.
Relative uptake of inorganics by different plant species	Unknown	Estimated plant BAFs for certain inorganics were based on BAF data for leafy produce grown in sewage sludge. Variability in type of plant and substrate may make the chosen BAF values an overestimate or underestimate of actual uptake.
Uncertainties Associated with Effects		
Lack of ingestion toxicity information for reptile and amphibian species	Unknown	Information is not available on the toxicity of contami- nants to reptiles or amphibians resulting from dietary exposures; as a result, dietary exposures to these receptors were not quantitatively evaluated in the AOC 57 ERA. Assuming the toxicities of analytes to mammals and birds are similar for these receptors, and to the extent that the dietary exposures for reptiles and amphibians are the same as for the tertiary consumers evaluated in the AOC 57 ERA, an assumption can be made that dietary exposures to reptiles and amphibians would result in similar risk- levels that were predicted for predatory mammals and birds. However, risks to reptiles and amphibians remain unknown.
Use of measurement endpoints	Overestimate	Although an attempt was made to have measurement end- points reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measurement endpoints that may overestimate assessment endpoints.
Failure to address potential community- level effects	Underestimate	Bulk toxicity studies to assess population risks to the midge (<i>Chironomus tentans</i>) and amphipod (<i>Hyalella</i> <i>azteca</i>) do not address the issue of effects on community structure and biodiversity.

TABLE 9-68 POTENTIAL SOURCES OF UNCERTAINTY IN ECOLOGICAL RISK ASSESSMENT AOC 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

Potential source	Direction of Effect on Risk	Justification
Uncertainties Associated with Risk Chara	cterization	
Meta-population level risk vs. individual population level risk	Overestimate	Defining ecological significance for common site-related receptors with limited home ranges is often difficult. Impact to one or more isolated populations may not have a meaningful impact on the ecosystem, unless competing species recolonize the disturbed habitats. This assessment conservatively treats impacts to a single indicator species population as a potentially significant risk of harm to the environment.
Risk evaluated for individual terrestrial re- ceptors only	Overestimate	Effects on individual terrestrial organisms may occur with little population-level effects. However, as the number of affected individuals and the extent of contamination increases, the likelihood of population-level effects increases.
Effect of decreased prey item populations on predatory receptors	Unknown	Adverse population effects to prey items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions yields high risk to ecological receptors, and may result in risk at background concentrations or the prediction of risks when there is no potential for adverse effects.
Summation of effects (HIs)	Unknown	The assumption that effects are additive ignores potential synergistic or antagonistic effects. It assumes similarity in mechanism of action, which is not the case for many substances. Compounds may induce toxic effects in different organs or systems.

Notes:

AOC = Area of contamination. CPC = contaminant of potential concern. TIC = tentatively identified compounds.

BAF = bioaccumulation factor.

HIs = hazard indices.

TAT 0-1 SUMMARY OF HUMAN H RISK ASSESSMENT AOC 57

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REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		CENTRAL TENDENCY		REASONABLE MAXIMUM		ARE SITE RISKS UNACCEPTABLE?	
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		🕂 Total 🐇	Total	Total	Total	Cancer Risk	Non-Cancer Risk
EXPOSURE MEDIUM	CEPTOR	Cancer	Hazard	Cancer	Hazard	(greater than	(greater than
		Risk	index with	KISK	index 1		Sector Current States
CURRENT/FUTURE LAND USE							
AREA 2 INDUSTRIAL							
Maintenance Worker							
Surface Soil		2E-07	0.01	2E-06	0.04	NO	NO
Tota	al Maintenance Worker Risk	2E-07	0.041	2E-06	0.04	NO	NO
AREA 2 RECREATIONAL							:
Recreational Child							
Surface Soil		5E-06	0.3	1E-05	0.7	NO	NO
Sediment		1E-05	0.3	3E-05	0.7	NO	NO
Surface Water		3E-06	0.07	6E-06	0.1	NO	NO
Tota	al Recreational Child Risk	2E-05	0.7	5E-05	1	NO	NO
AREA 3 INDUSTRIAL							
Maintenance Worker							
Surface Soil		3E-07	0.008	4E-06	0.03	NO	NO
Tota	ai Maintenance Worker Risk	3E-07	0.008	4E-06	0.03	NO	NO
AREA 3 RECREATIONAL							
Recreational Child							
Surface Soil		3E-06	0.2	6E-06	0.5	NO	NO
Sediment		2E-06	0.07	6E-06	0.1	NO	NO
Surface Water		3E-06	0.04	5E-06	0.1	NO	NO
Tota	al Recreational Child Risk	8E-06	0.3	2E-05	0.7	NO	NO

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TA* 0-1 SUMMARY OF HUMAN / I'H RISK ASSESSMENT AUG 57

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

		CENTRAL	TENDENCY	REASONABL	EMAXIMUM	ARE SITE RISKS	INACCEPTABLE?
EXPOSURE MEDIUM	RECEPTOR	Cancer	Hazard	Cancer	Hazard	(greater than 1x10 ⁴ - 1x10 ⁴).	(greater than HI=1) ²
			ANTAL OF CONTRACTOR				
PUSSIBLE FUTURE LAND U	5E						
AREA 2 INDUSTRIAL							
Commercial/Industrial Worker							
Surface Soil		1E-06	0.06	7E-06	0.1	NO	NO
Groundwater *			0.07	75-06	0.07	NO	NO
	Total Commercial/Industrial Worker Risk	12-00	0.1	12-00	0.2		
Construction Worker							
Surface Soil Subsurface Soil		6E-07 2E-07	0.5 0.2	1E-06 6E-07	0.5 0.2	NO NO	NO NO
	Total Construction Worker Risk	8E-07	0.7	2E-06	0.7	NO	NO
AREA 2 RECREATIONAL							
Construction Worker							
Surface Soil		1E-06	1	3E-06	1 3	NO	NO YES
Subsurface Soil		16-00	3	5E-05	3	NO	VES
	Total Construction Worker Risk	25-00	4	02-00	4		120
AREA 3 INDUSTRIAL							
Commercial/Industrial Worker							
Surface Soil		2E-06	0.04	1E-05	0.1	NO	NO
Groundwater ³		5E-05	2	2E-04	2	YES	NO "
	Total Commercial/Industrial Worker Risk	5E-05	2	2E-04	2	YES	NO ⁴
Construction Worker							
Surface Soil		1E-06	0.8	2E-06	0.8	NO	NO
Subsurface Soil		3E-07	0.2	02-07	0.2	NO	NO
	Total Construction Worker Risk	1E-06	1	32-05	1		NU
AREA 3 RECREATIONAL							
Construction Worker							
Surface Soil		8E-07 8E-07	0,6 0,4	1E-06 1E-06	0,6 0.4	NO NO	NO NO
t/aec/devens/aoc57/hhrafinal/tables/Ta	ble10-1.xls Total Construction Worker Risk	2 2E-06	1	2E-06	1	NO	6/2/00 NO

TA' 10-1 SUMMARY OF HUMAN TH RISK ASSESSMENT

REMEDIAL INVESTIGATION REPORT DEVENS, MASSACHUSETTS

	CENTRALT	ENDENCY	REASONAB	EMAXIMUM	ARE SITE RISKS	UNACCEPTABLE?
EXPOSURE MEDIUM RECEPTOR	Total Cancer	Total Hazard	Total Cancer	Total Hazard	Cancer Risk (greater than	Non-Cancer Risk
	Risk	Index	Risk	Index	1x10*-1x10*) '	네르1)* .
UNRESTRICTED FUTURE LAND USE						
AREA 2 INDUSTRIAL						
Adult Resident						
Surface Soil	-	-	7E-06	0.1	NO	NO NO
Groundwater ³	_	_	-	0.2	-	NO
Child Resident						
Surface Soil			25.05	2	20	NO 4
Subsurface Soil	-		9E-06	0.3	NO	NO
Total Resident Risk ⁵		**	4E-05	0.3/2	NO	NO / NO ⁴
AREA 2 RECREATIONAL						
Adult Resident			2			
Surface Soil			2E-05	0.3	NO	NO
Groundwater ³	_		2E-05 1E-03	1 7	YES	NU YES
Child Resident			12 00	·	120	
Surface Soll			65-05	A	NO	VEQ
Subsurface Soil	-	-	6E-05	19	NO	YES
Total Resident Risk ⁵		-	1E-03	8/23	YES	YES / YES
AREA 3 INDUSTRIAL						
Adult Resident						
Surface Soil Subsurface Soil		 	1E-05 3E-06	0,1 0.03	NO NO	NO NO
Groundwater ³		-	6E-04	5	YES	YES
Child Resident						
Surface Soil	-		4E-05	1	NO	NO
Subsurface Soil	-		9E-06	0.3	NO	NO
Total Resident Risk ⁵	-		7E-04	5/1	YES	YES / NO

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		Alterna Antonio antonio alterna
/SSD-93-01B		1 Karal
SSW/SSD-S	93-92FA	
	SD-94-33	CSD-94-34X
-30X (CSD-94-32X	,	
CSD-94-31X		
		LEGEND
	4	RI SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
	Δ	PREVIOUS SURFACE WATER/ SEDIMENT SAMPLING LOCATIONS (SSW/SSD-93-XXX = APPROXIMATE)
	Δ	1994 LOWER COLD SPRING BROOK SI SURFACE WATER/SEDIMENT SAMPLING LOCATIONS
	٥	1994 COLD SPRING BROOK SI SURFACE WATER/SEDIMENT AND BIOASSESSMENT STATION
JUK	•	MONITORING WELL
		RESERVATION BOUNDARY
		DRAINAGE COURSE
		RAILROAD TRACKS
~ X ~ ~ X	x	FENCE

0	200	400	800	FEET
	en e			

SCALE: 1"=400'

FIGURE 5-6 COLD SPRING BROOK SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS AOC 57 REMEDIAL INVESTIGATION REPORT DEVENS, MA.



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••••• 0 •••••••• 0	lerh W/Barbed Mre
220	CONTOUR
(EDGE OF WOODS
.	1998 PIEZOMETER LOCATIO
*	1998 SW/SED LOCATION
Å	1998 SURFACE/SUBSURFAC SOIL SAMPLE LOCATION
\$	MONITORING WELL
-\$	PIEZOMETER
*	SURFACE WATER/ SEDIMENT SAMPLE
- 수	TERRAPROBE
+	test pit
+	BORING
⊕ CSD-94-26X	PREMOUS SEDIMENT SAMPLING LOCATION
	STREAM FLOW
	STREAM CHANNEL
- · · · ·	LIMITS OF BORDERING VEGETATED WETLANDS
	STONE SWALE
A A'	CROSS SECTION ORIENTATION
570-05-107	
<i></i>	
	FIGURE 6-
OHIENTATION O	FGEOLOGIC

DEVENS, MA 11____H. . . .





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FIGURE 6-4 INTERPRETIVE GEOLOGIC CROSS SECTION B-B' AOC 57/AREA 2 **REMEDIAL INVESTIGATION REPORT** DEVENS, MA



FIGURE 6-5 INTERPRETIVE GEOLOGIC CROSS SECTION C-C' AOC 57/AREA 3 **REMEDIAL INVESTIGATION REPORT** DEVENS, MA Hardina I awann Aaansiataa



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FIGURE 6-6 INTERPRETIVE GEOLOGIC CROSS SECTION D-D' AOC 57/AREA 3 REMEDIAL INVESTIGATION REPORT DEVENS, MA Autors Aressinter







FIGURE 6-9 AOC 57/AREA 3 REMEDIAL INVESTIGATION REPORT DEVENS, MA



FIGURE 6-10 AOC 57/AREA 3 REMEDIAL INVESTIGATION REPORT DEVENS, MA





		Site ID Uni	= 575-98-04X ts = mg/kg		
)epth	TPHC	TPHC	EPH	EPH	EPX
	On-Site	Off-Site	n-C9 to n-C18	nC19 to nC36	n-C11 to n-C22
Feet	570	NA	NA	NA	NA
Foot	680	1150	< 37	260	140





<u>LEGEND</u>

• • • •	CHAIN LINK FENCE W/BARBED WIRE
220	TOPOGRAPHIC CONTOUR
······	EDGE OF WOODS
	SOURCE AREA EXCAVATION BOUNDAR
.	1998 PIEZOMETER LOCATION
Å	1998 SW/SED LOCATION
Å	1998 SURFACE/SUBSURFACE SOIL SAMPLE LOCATION
•	EXISTING MONITORING WELL
÷	EXISTING TERRAPROBE
\$	EXISTING TEST PIT
- † -	EXISTING BORING
NA	NOT ANALYZED

	·	Site ID Unit	= 57S-98-15X s = mg/kg		
Depth O Feat 3 Feet	TPHC On-Site 960 < 270	TPHC Off-Site NA < 27.9	EPK n-C9 to n-C18 NA < 37 J	EPH n-C19 to n-C36 NA < 37	EPH n-Cl1 to n-C22 NA < 37
	Site (D = 575-98-14X Ibils = mo.ko				
Depth O Feet 1 Foot	TPHC On-Site 2900 1200	TPHC Off-Site NA 895	EPH n-C9 to n-C18 NA < 40 J	ЕРН nC19 to nC36 NA 150	ЕРН яС11 to nС22 NA 75 J
Site 10 = 575-98-16X Units = mg/kg					
Depth O Feet 2 Feet	TPHC On-Site 810 < 260	TPHC Off-Site NA NA	EPH a-C9 to n-C18 NA NA	EPH n-C19 to a-C36 NA NA	EPH n-C11 to n-C22 NA NA

Sile ID = 57D-98-07X Units = mg/kg				
TPHC On-Site	TPHC Off-Site	EPH n-C9 to n-C18	EPH n-C19 to n-C36	677위 n-C11 to n-C22
5500	200	< 69 J	< 69	< 69
<u> </u>				

	Site ID = Units	57D-98-06X = mg/kg		
	TPHC	EPH	EPH	EPH
(Off-Site	n-C9 to n-C18	n-C19 to n-C38	n-C11 to n-C22
	160	< 63 J	< 63	< 63
		the second s		

Site ID = Units	57D-98-08X = mg/kg		
HC	EPH	EPH	EPH
-Site	n-C9 to n-C18	n-C19 to n-C36	n-Ci1 to n-C22
09	< 50 J	< 50	< 50

FIGURE 7-4 1998 TPHC AND EPH CONCENTRATIONS IN SOIL AND SEDIMENT AOC 57/AREA 3 REMEDIAL INVESTIGATION REPORT DEVENS, MA Harding Lawson Associates



	57E Unitsi	-96-08X UGL
probenzene		5,8
roethene		3.2
506		6.4 26.2
ne	2002 - 10 - 10 - 10 - 10 - 10 - 10 - 10	7.1 J

	57M	-96-11X
	Unitsi	UGL
enzene		2.5
hene		2.7
		2.6
		8./

LEGEND

Chan link fence with barged wre



FIGURE 7-5 **GROUNDWATER 1996 FIELD ANALYTICAL DETECTS** AOC 57/AREA 3 **REMEDIAL INVESTIGATION REPORT** DEVENS, MA Llaventina E accordin A and atula a _





Site ID: 57H Sample Date: 10 Depth: 10 Units:	-95-03 /02/96 /up/	X 68 L
HETALS Ansen IC Cadmium	33. 8.6	2
SEMIVELATILE DRGANICS 1,2-dichtorobenzene 2-methylnophthalene 4-methylphenol Naphthalene	9. 5. 4. 1.	86450
VOLATILE (DRGANICS #1,2-dichioroethylenes (cis And Trans) 1,1,1-tichioroethylenes Carbon Tetrachioride Chioroforn Ethylbenzene Styrene Tetrachioroethene Tolcheroethylene Xylenes	< 4, 4, 4, 1,5 20	555000000000000
 DTHER Total Petroleum Hydrocarbons	< 16	7

57H	-91 1 0,	6-10X1 /02/96	
		ug/Ľ	
	< <	2,54 3,01	
ILE DRGANICS probenzene probenzene pphthalene henol ne	~~~~	1.7 1.7 1.7 .52 .5	
BRGANICS Loroethylenes (cls And Trans) chlorethane trachloride n ne noethene -turkee	~~~~~~~	າວອີລາກວຸດອຸງ ອີລາກວຸດອຸງ	
ethylene	۲ ۲	.5 .84	
roleun Hydrocarbons	<	167	

LEGEND



CHAIN LINK FENCE CONTOUR EDGE OF WOODS Konstoring Well test pit BORING

FIGURE 7-7 1996 OFF-SITE ANALYTICAL **GROUNDWATER RESULTS** AOC 57 **REMEDIAL INVESTIGATION REPORT** DEVENS, MA Harding Lawoon Accordates











¹ Petroleum has not migrated to groundwater, however reducing conditions created by oil release may have caused leaching of naturally occurring inorganic constituents from subsurface soil.

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ERA = Ecological risk assessment * = Shading indicates the exposure pathways that are quantitatively evaluated for receptors in the AOC 57 ERA. Nonshaded pathways are evaluated qualitatively, not evaluated due to the lack of toxicity information, or not evaluated because it is not considered a significant pathway. FIGURE 9-3 CONTAMINANT PATHWAY MODEL FOR ECOLOGICAL RECEPTORS EXPOSED TO AOC 57 SURFACE SOIL, SURFACE WATER, SEDIMENT, AND GROUNDWATER REMEDIAL INVESTIGATION REPORT AOC 57 DEVENS, MA





