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PHASE II COMPREHENSIVE SITE ASSESSMENT REPORT
RTN: 3-0017087

RUSSELL FIELD
RINDGE AVENUE
CAMBRIDGE, MASSACHUSETTS

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LIST OF ABBREVIATIONS AND ACRONYMS

ACEC	Area of Critical Environmental Concern
ACM	asbestos-containing material
ADD	Average Daily Dose
ADE	Average Daily Exposure
ANI	Alewife Neighbors, Inc.
AP	averaging period
AUL	Activity and Use Limitation
BWSC	Bureau of Waste Site Cleanup
CAO	Cambridge Asbestos Ordinance
CF	units conversion factor
cm	centimeter
COC	Contaminant of Concern
DCR	Massachusetts Department of Conservation and Recreation
ED	exposure duration
EF	exposure frequency
ET	exposure time
EH&E	Environmental Health & Engineering, Inc.
ELCR	Excess Lifetime Cancer Risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
EPH	extractable petroleum hydrocarbon
f/cm^3	fibers per cubic centimeter
f/ml	fibers per milliliter
Grace	W.R. Grace
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
IRIS	Integrated Risk Information System
MADEP	Massachusetts Department of Environmental Protection
MBTA	Massachusetts Bay Transportation Authority
MCP	Massachusetts Contingency Plan
m	meters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NIOSH	National Institute for Occupational Safety and Health
OHM	oil or hazardous material
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	tetrachloroethene (perchloroethene)
PCME	phase contrast microscopy equivalent
PEL	permissible exposure limit
PID	photoionization detector
PLM	polarized light microscopy
PP13	13 Priority Pollutant Metals
PSA	Pine & Swallow Associates, Inc.
PVC	polyvinyl chloride

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LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

RAF	Relative Absorption Factor
RC	Reportable Concentration
RCGW-2	Reportable Concentration for Ground Water Category 2
RCS-1	Reportable Concentration for Soil Category 1
RfC	reference concentration
RfD	reference dose
SVOC	semivolatile organic compound
s/cm^3	structures per cubic centimeter
TDR	time domain reflectometry
TEM	transmission electron microscopy
TIC	tentatively identified compound
UCL	Upper Concentration Limit
UTM	Universal Transverse Mercator
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
μg/m^3	micrograms per cubic meter

1.0 INTRODUCTION

Environmental Health & Engineering, Inc. (EH&E) has prepared this Phase II Comprehensive Site Assessment Report for the City of Cambridge (the City) in accordance with the Massachusetts Contingency Plan (MCP). Contaminants were detected in subsurface soil at Russell Field, a City-owned facility; the Massachusetts Department of Environmental Protection (MADEP) Release Tracking Number for this release is 3-0017087. Figure 1, Site Location Map, in Appendix C illustrates the location of the Russell Field Site (the Site). The Comprehensive Response Action Transmittal Form (BWSC108) is located in Appendix B.

This Phase II Comprehensive Site Assessment Report summarizes information obtained during Phase I Site Assessment activities, December 1997 through February 1998, and details Phase II Site Assessment activities conducted August 25, 1999; July 8 through 16, 2002; May 27, 2003 through June 5, 2003; and November 18, 2003 through December 2, 2003. A Phase I Site Assessment Report and Tier Classification was submitted to the MADEP on July 23, 1999 under release tracking number 3-0017087. Russell Field is a Tier II site.

A Notice of Delay was submitted to MADEP on July 23, 2001. The primary reason for delay in completion of Phase II and Phase III assessments was the lack of MADEP policy and guidance on assessment, risk characterization, and management of asbestos in soil. In addition, the schedule was impacted by the need to address neighborhood concerns, integrate park renovation design, and comply with the Cambridge Asbestos Ordinance (CAO).

Much of the assessment work completed subsequent to Phase I at the Russell Field Site supported CAO compliance. This conservative and protective ordinance governs the management of soils containing asbestos fibers (not debris) at concentrations equal to or greater than 1%. Full assessment in accordance with the CAO could not be completed until 100% design drawings for field renovation were issued in October/November 2003. Subsequent to receipt of these plans, the final sampling program was completed. The Site is fully compliant with the CAO and results of testing

for CAO compliance are included in this Phase II Report. However, CAO compliance, as described, significantly impacted the Phase II assessment schedule for the Site.

Alewife Neighbors, Inc. (ANI) is a local citizens group. Throughout the Phase I and Phase II assessment programs, the City has provided ANI with access to the Site to perform oversight during field activities and for the collection of split samples. Results of sample analysis by ANI (or their consultants) are included in this assessment.

2.0 SITE DESCRIPTION

Russell Field is located off Rindge Avenue in Cambridge and is owned by the City. The MADEP Release Tracking Number for the Site is 3-0017087. The Site Location Map, Figure 1 in Appendix C, is a topographic map showing the location of the Russell Field Site with the 500 foot and one-half mile radii indicated. In addition, the disposal site boundaries are illustrated. The map coordinates of the Site are shown in Table 2.1.

Table 2.1 Site Coordinates

	(deg:min:sec)	**UTM (meters)**
Latitude	42.395529 North	Northing: 4695693
Longitude	-71:137932 East	Easting: 324034

UTM Universal Transverse Mercator

The Site is located in an urban mixed-use area of Cambridge near the Alewife Massachusetts Bay Transportation Authority (MBTA) Red Line Station. The 8.9 acre Site is a City park and includes baseball, soccer, and football fields. Site features are illustrated on Figure 2 in Appendix C. In addition, a commuter bike path is located along a portion of the periphery of the Site. Structures at the Site include bleachers at the football field. A parking area is located at Rindge Avenue. A Massachusetts Department of Conservation and Recreation (DCR) (formerly the Metropolitan District Commission) operated pool and pool house are located on an abutting property. The areas surrounding the park consist of residential areas, the MBTA's headhouse for the Alewife subway station, and the W.R Grace (Grace) facility, which includes Jerry's Pit. The Site is adjacent to and east of the Grace property, a former manufacturing facility, which is listed with the MADEP Bureau of Waste Site Cleanup (BWSC) as a Tier IC disposal site (RTN 3-0000277). The MBTA subway tunnel crosses beneath a portion of Russell Field, its approximate location is shown on Figures 2 and 3 in Appendix C.

Residential areas are located north, east, and south of the Site. Based upon a review of U.S. Census data for the year 2000, approximately 13,000 people live within one-half mile of the Site. No institutions as described in 310 CMR 40.0483 have been identified within 500 feet of the Site.

Topography at Russell Field is relatively flat across the Site; the western portions of the Site are elevated relative to the Grace property and Jerry's Pit. Topography surrounding the area is shown on Figure 4 in Appendix C.

Figure 4 in Appendix C is a map representing natural resource areas within a half-mile radius of the Site. These include the Alewife Brook and protected open spaces. No drinking water supplies are known to be located within one-half mile of the Site. One agricultural-use private well, which is not in use, is located within one-half mile northwest of the Site. No Areas of Critical Environmental Concern (ACECs), as defined by the MCP, are located within one-half mile of the disposal site boundary.

Alewife Brook is located approximately two-tenths of a mile (approximately 320 meters) northwest of the Russell Field disposal site boundary. Contained in the Mystic River Basin, Alewife Brook flows in a northeast direction into the Mystic River, eventually reaching Boston Harbor. The entire length of Alewife Brook is classified as a Class B Inland Water with Warm Water Restrictions. Class B waters, as defined in the Massachusetts Surface Water Quality Standards 314 CMR 4.00, are designated as habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated, they shall be suitable as a source of public water supply with appropriate treatment. In addition, they shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. Class B waters have consistently good aesthetic value. A Warm Water fishery describes waters with maximum mean monthly temperatures generally exceeding 68 degrees Fahrenheit (20 degrees Celsius) during the summer months and is capable of sustaining a year-round population of cold water stenothermal aquatic life.

The disposal site is within one-half mile of a MADEP Zone A, Zone B, and Zone C Surface Water Protection Area, as defined by the MCP. Zone A represents the land area within a 400-foot lateral distance from the upper boundary of the bank of a Class A surface water source. MADEP-designated Zone B Surface Water Protection Areas represent the land area within one-half mile of the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a), or the edge of a watershed, whichever is less. Zone B always includes the land area within a 400 foot lateral

distance from the upper boundary of the bank of the Class A surface water source. Figure 5 in Appendix C, Natural Resources and Aquifers, shows the Zone B and Zone C Surface Water Protection Areas.

Figure 5 illustrates aquifer classifications for water-bearing strata in the Site vicinity. No aquifer resource areas are located within 500 feet of Russell Field. Medium and high yield aquifer zones are located approximately one-half mile southwest of the Site near Fresh Pond.

As illustrated in Figure 5, much of the Site lies within the Federal Emergency Management Agency 500-year flood zone. No portion of the Site lies within the FEMA 100-year flood zone.

3.0 SITE HISTORY

3.1 OWNER/OPERATOR AND OPERATIONS HISTORY

Table 3.1 Operational History

Dates	Owner/Operator	Use
1913 to present	City of Cambridge	Public Park
Prior to 1913	Thomas G. Kent, Elizabeth Mittelbach, et al., and New England Brick Company	Undeveloped land

Russell Field is a municipal recreational facility located in North Cambridge, Massachusetts. The Site is bounded by Rindge Avenue to the south, the Grace property to the north, the MBTA Alewife Station (Alewife Station) to the west, residential properties to the east, and several pedestrian pathways, including Linear Park. The park includes a football field, soccer field, and two baseball diamonds; a DCR swimming pool is located on an abutting property to the east. The Site is heavily used by athletic teams and area residents and serves as a pedestrian route to Alewife Station (see Figure 2, Appendix C).

In the early to mid-1980s, Russell Field was used as a staging area by the MBTA during construction of the Red Line extension to Alewife. The Red Line tunnel runs under a portion of the Site (Figures 2 and 3, Appendix C).

Beginning in 2004, the Site will be closed off to the public while the City of Cambridge performs a large site renovation and upgrade. Any remediation required for CAO and MCP compliance will be completed in conjunction with the renovation project.

3.2 RELEASE HISTORY

The original investigation of Russell Field, conducted at the request of the City, was undertaken to assess the potential presence of contamination on Russell Field from MBTA development activities that took place during construction of the Red Line Extension, from migration from the adjacent Grace property, or other sources. The Grace parcel is currently listed as a hazardous waste site by the MADEP. The work plan for this investigation was developed by a joint committee that included representatives

from ANI, the City of Cambridge Community Development Department, and EH&E as the City's environmental consultant. Pine & Swallow Associates, Inc. (PSA) was hired by the City to conduct the 1998 field investigation at Russell Field. EH&E was contracted to provide field oversight, evaluate data, produce assessment reports, and provide MCP compliance services.

Contaminants discovered at the Site in 1998 resulted in a 120-day reportable condition. The MADEP BWSC received notification of the historic hazardous materials release on July 23, 1998 and the Site was assigned release tracking number (RTN) 3-0017087. Release details are summarized in Table 3.2.

Table 3.2 Identified Releases at Russell Field

Release Tracking Number	3-17087
Source and location	Off Rindge Avenue, Cambridge
Known or suspected cause	Historical source(s)
Known or approximate date and duration	Historical source(s)
Type of oil and/or hazardous material	PAHs, asbestos, metals in soil
Known or approximate volume	unknown
Any measures taken to assess, contain, or mitigate	Phase I and Phase II assessments

PAHs polycyclic aromatic hydrocarbons

3.3 OIL AND/OR HAZARDOUS MATERIALS USE AND STORAGE HISTORY

The only current uses of oil or hazardous materials at the Site are incidental uses during grounds maintenance. Grounds maintenance equipment is not stored on-site.

The DCR owns the pool and pool grounds encompassed by the park. It is assumed that the DCR stores water treatment chemicals for the pool. However, the pool and pool grounds are not within the disposal site boundary.

As previously discussed, the MBTA and its contractors used the Site as a staging area during the construction of the Red Line extension to Alewife Station. Contaminated soils from excavation activities, as well as construction supplies and equipment were believed to have been stored at the Site at that time.

No underground storage tanks are known to exist at the Site.

3.4 ENVIRONMENTAL PERMITS AND COMPLIANCE HISTORY

The City does not currently maintain any environmental permits for hazardous waste, wastewater discharge, or air emissions at this facility. Historical use of the Site as a public park did not require environmental permits.

3.5 SITE INVESTIGATIONS

A number of environmental investigations have been completed at the Site since 1998. Investigations have been conducted to meet MCP and CAO requirements. The following is a list of reports completed to date. Information contained within these reports as well as information obtained during additional field investigations were utilized to complete this Phase II Comprehensive Site Assessment.

Phase I investigations and interim reports:

- EH&E Draft Report, *Environmental Site Assessment: Surficial Conditions at Russell Field*, March 20, 1998.
- EH&E Final Report, *Environmental Site Assessment: Subsurface Conditions At Russell Field*, October 22, 1998.
- EH&E *Final Report of Results of Subsurface Asbestos Investigation at Russell Field*, October 7, 1998.
- EH&E Final Report, *Phase I—Initial Site Investigation Report*, July 23, 1999.

Phase II investigations and interim reports:

- EH&E *Results of Asbestos Air Monitoring at Russell Field* (letter report to Susanne Rasmussen, City of Cambridge), November 29, 1999.
- EH&E *Supplemental Site Assessment Report, Cambridge Asbestos Ordinance Compliance*, April 24, 2003.
- EH&E *Imminent Hazard Evaluation, Geotechnical Program*, August 5, 2003.

- EH&E *Supplemental Site Assessment Report II, Cambridge Asbestos Ordinance Compliance*, March 2004.

3.5.1 Phase I (Previous) Investigations

In response to neighborhood concerns, a surficial soil sampling program was developed to assess the potential presence of contaminants in surficial soils on Russell Field from reported historic land use activities at the field and on adjacent properties. This program was completed in Spring 1998. Surficial sampling locations are illustrated in Figure 6.

The first subsurface soil investigation at Russell Field was conducted through the completion of a soil boring program between June 17, 1998 and July 7, 1998. The soil boring program consisted of the advancement of borings at 17 locations and the installation of 15 ground water monitoring wells (PS-series). These sampling locations are illustrated in Figure 2. Results indicated that MADEP notification was required due to the presence of asbestos, polycyclic aromatic hydrocarbons (PAHs), and metals in soil.

Therefore, in a second round of subsurface investigation (May 1999), 79 borings (the A-series) and two additional wells (A-109 and A-110) were completed. All but 15 of these borings were shallow (0 to 3'), and samples from this interval in all borings were screened for asbestos. Additional analytes were selected for the 15 deep borings (designated A-101 to A-115) and selected shallow borings. The deeper borings ranged from 8 to 15 feet in depth, except at A-112 where refusal was repeatedly encountered at 2 feet. Borings were completed on a 75-foot grid across the field. Results confirmed the presence of asbestos and concentrations of metals and PAHs above Reportable Concentrations (RCs). These sampling locations are illustrated in Figure 2.

Results of the sampling programs completed in 1998 and 1999 were submitted to the MADEP under RTN 3-0017087 in the form of a Phase I Site Assessment and Tier Classification report on July 23, 1999. The Site is currently listed with the MADEP BWSC as a Tier 2 disposal site.

In summary, Phase I investigations included the completion of 96 borings and 17 ground water wells. Soil and ground water were sampled and analyzed for a wide range of

compounds, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, sulfate, and cyanide. In addition, soil was analyzed for asbestos. Analytical results indicated that PAHs and metals are present in soil fill at concentrations exceeding MADEP RCs and confirmed the presence of asbestos in soil. In general, topsoil at the Site did not contain concentrations of site contaminants above RCs. No contaminants were detected in ground water at concentrations exceeding RCs. A more detailed discussion of these results is provided in Section 5.0.

3.5.2 Phase II Investigations

Additional site assessment activities have been conducted as comprehensive response actions since the July 23, 1999 Phase I Report. The results of these investigations are detailed in this Phase II Report and listed below.

- August 1999—Asbestos Air Monitoring Program. Included sampling at 23 locations to assess the potential for airborne asbestos under current Site conditions.

- July 8, 2002 through July 16, 2002—Supplemental Site Assessment for Cambridge Asbestos Ordinance Compliance (report dated April 24, 2003). Included the advancement of 281 soil borings (A- and B-series) and perimeter air monitoring. All soil samples were analyzed for asbestos. Selected soil samples were also analyzed for additional analytes. See Figure 2 for boring locations.

- May 27, 2003 through June 5, 2003—Geotechnical Engineering Study conducted by EnviroSense, Inc. and Weber Engineering Associates, LLC to provide recommendations to architects for field renovations and field house construction. Included the advancement of 12 soil borings (ESB-series) to depths of approximately 26 feet below ground surface or greater and perimeter air monitoring. A limited number of soil/debris samples were collected and analyzed for asbestos based upon field observations. See Figure 3 for boring locations.

- November 18, 2003 through December 2 2003—Supplemental Site Assessment for Cambridge Asbestos Ordinance Compliance. Advancement of 202 (C-series) soil borings to depths ranging from 3 to 16 feet below ground surface, and perimeter air

monitoring. All soil samples were analyzed for asbestos. Selected soil samples were also analyzed for PAHs and metals. See Figure 3 for boring locations.

Results of Phase II Investigations, which were conducted to further define the nature and extent of soil contamination at Russell Field, and to satisfy the requirements of the CAO, are described in Sections 4.0 and 5.0.

4.0 SITE HYDROGEOLOGY

Site hydrogeology is described in this section and is based upon the field investigations completed to date at the Site. These field activities included the installation of soil borings and monitoring wells, and the observation of soil and ground water conditions, as described in this section.

4.1 SITE SUBSURFACE SOIL CHARACTERISTICS

Based upon observations made throughout the field drilling programs, Site geology can basically be described as a layer of "topsoil" (typically less than one to two feet in depth) overlying fill (see boring logs in Appendices H, I, and J). With the exception of the baseball diamonds, most of the Site is either vegetated or covered with asphalt. The fill layer is highly variable in nature across the Site and ranges from relatively clean fine-to-medium sand and silt to coarser-grained fill material (boulders and cobbles) containing miscellaneous debris, such as fragments of brick and cement. Coal-like materials and chunks of dark, lightweight, rock-like substances (klinkers or coal-ash) were also observed at various boring locations throughout the Site, within the fill layer. Other non-identifiable anthropogenic materials were observed in the fill. At a limited number of locations, debris in fill included asbestos-containing material (ACM).

The fill ranges in depth and thickness across the Site, and is underlain by fine sand and silt, and clay with interbedded silt, which are interpreted to be native materials. EH&E evaluated fill patterns by separating the Site into areas for comparison. Within these areas, there is still a degree of variability in the depth to the start of the fill layer, the total depth of the fill layer, and the thickness of the fill layer. EH&E reviewed boring logs collected during the assessment programs to ascertain characteristics of the fill layer depths. Borings were assessed and compared to each other based upon Site features and historical information. The areas compared are the approximate locations of the parking lot, Comeau Field, Samp Field to Clifton Street entrance, football and soccer fields, the area identified as being in the vicinity of the MBTA tunnel, and the portion of the parcel providing public access to Alewife Station, which includes the future field house and playground located along the western property line (see Figure 7 for Site features).

The fill layer within the parking lot in the southwestern portion of the Site commonly ranges from a depth of 6 inches to 7.5 feet below ground surface. The parking lot is overlain by asphalt that ranges in thickness across the lot at 3 to 6 inches. The total average thickness of the fill layer within the parking lot is estimated at 5 feet.

The depth of the fill layer across Comeau Field ranges from approximately 1 foot below ground surface to up to 8.5 feet below ground surface. In some areas of Comeau Field, the fill layer was noted to begin at depths of 6 inches below ground surface.

Across Samp Field to the Clifton Street Entrance, the average depth to the beginning of the fill layer is 6 inches and extends to depths of 7.5 feet below ground surface. There appears to be no consistent depth to or extent of the fill layer in this area.

Within the soccer and football field limits, the fill layer ranged from a depth of approximately 6 inches to a maximum depth of 8 feet across this area. The average thickness of the fill layer within the soccer and football field is approximately 4.5 feet.

The deepest fill observed at sixteen feet below ground surface was noted in geotechnical boring ESB9 and C-series boring C202 (Figure 3). These borings are located in the area of the MBTA tunnel. Along this portion of the Site where the MBTA tunnel is anticipated to exist, the fill depth ranged from approximately 6 inches to 16 feet below ground surface. The average depth to the fill layer across this portion of the Site is approximately 6 inches and extends to an average of 7.5 feet below ground surface with an average thickness of 5.5 feet.

Along the western property line where the future field house and play area are planned, the typical depth to fill is 1 foot below ground surface and extends to up to 7 feet below ground surface.

In summary, although the depth to, thickness of, and extent of the fill layer is highly variable across the Site, there appears to be some consistency within some portions of the Site. As noted above, excluding the area underlain by the MBTA tunnel, the depth to fill typically ranges from 6 inches to 1 foot below ground surface, and the fill layer

extends to a depth of 7 to 8.5 feet below ground surface. In the area of the MBTA tunnel, the depth of fill may extend from 6 inches below ground surface to up to 16 feet below ground surface. This change in fill depth may be due to Site activities conducted by the MBTA during installation of the tunnel. Bedrock was never encountered at Russell Field at depths up to 56 feet.

4.2 GROUND WATER FLOW

As described in the Phase I Report dated July 23, 1999, the interpreted flow patterns in overburden (soil) indicate that ground water flows toward the northwest across the Site with a northerly component in the central portion of the Site. Shallow ground water may be discharging to the tunnel subdrain system and/or to nearby Alewife Brook. The hydraulic gradient across the Site is estimated at approximately 0.008, and ranged from 0.007 in the southern portion of the Site to 0.026 in the northern portion. This may be due to local variations in subsurface stratigraphy, the MBTA tunnel's impact in the northern portion of the Site, or local recharge conditions.

No additional assessment of ground water quality or flow direction has been conducted since completion of initial Site assessment activities in 1998 through 1999, because no contaminants were detected in ground water at concentrations at or exceeding MADEP criteria.

5.0 NATURE AND EXTENT OF CONTAMINATION

The purpose of this section is to describe the nature and extent of contamination at the Site by summarizing the results of field activities and laboratory analyses for soil, ground water, and air. For each of the environmental media (soil, ground water, and air), methods are first described and results are described subsequently. Phase I results are summarized; Phase II results are presented in detail.

5.1 GROUND WATER SAMPLING AND ANALYSIS

5.1.1 Methods

During initial Site assessment activities as part of Phase I, ground water samples were obtained from on-site monitoring wells for laboratory analysis on July 8, 1998 and May through June 1999.

On July 8, 1998, ground water samples were collected by PSA from wells PS-1 through PS-15, except for PS-12, which was installed for ground water elevation data only. In addition, one duplicate sample was collected from PS-5 and one VOC trip blank was analyzed for quality assurance/quality control purposes. Ground water samples were analyzed for VOCs (U.S. Environmental Protection Agency [EPA] Method 8260) plus tentatively identified compounds (TICs), SVOCs (EPA Method 8270) plus TICs, PAHs (gas chromatography/mass spectrometry-SIM), 13 Priority Pollutant Metals (PP13), sulfite, sulfate, total cyanide, and pH. Samples collected for analysis of metals were filtered in the laboratory where the preservative was applied. In addition, ground water was monitored in the field for pH, dissolved oxygen, specific conductivity, and temperature.

Between May 27 and June 7, 1999, a second round of ground water samples was collected. One ground water sample was taken from each monitoring well, including two newly installed polyvinyl chloride (PVC) wells (A-109 and A-110; Figure 2). Previously installed wells are microwells constructed of steel. Ground water was monitored in the field for pH, dissolved oxygen, specific conductivity, temperature, and ground water elevation. All of the spring 1999 ground water samples were analyzed for nickel, these samples were filtered and preserved in the field. In addition, one water sample was

collected from PS-13 and analyzed for chlorinated solvents; this sample was collected prior to collection of the nickel sample from this well. Two duplicate samples (for nickel analysis) and one VOC trip blank were analyzed for quality assurance/quality control purposes.

Locations of wells installed by PSA are included on Figures 2 and 3 in Appendix C and are identified as PS-series.

Sampling and analytical methods are described in detail in the Phase I Report. The Phase I Report contains all ground water data and validation reports referenced in this Phase II Report.

5.1.2 Results

5.1.2.1 Field Parameters

Field measurements of pH, temperature, dissolved oxygen, and specific conductance are summarized in the Phase I Report. Review of temperature and pH data indicates no specific trends. The dissolved oxygen and specific conductance results varied considerably. The range of results suggests that oxygen may not be present in some of the ground water samples (PS-1, PS-3, PS-7, PS-8, PS-9, PS-10, and PS-11) and may be at saturation in PS-4. This may indicate that ground water in a reducing environment is present in some portions of the Site. Local biological conditions likely affect these results.

5.1.2.2 VOCs

Results of the VOC analyses (Phase I Report) indicate that no compounds were reported above MCP Reportable Concentrations for Ground Water Category 2 (RCGW-2). During Summer 1998 sampling, chlorinated compounds (including cis-1,2-dichloroethene, chloroform, trichloroethene, and tetrachloroethene) were identified in ground water in the central portion of the Site between PS-15 and PS-10. The highest concentrations of these compounds were observed at PS-13, where tetrachloroethene, cis-1,2-dichloroethene, and trichloroethene were reported at an estimated concentration of 470 micrograms per liter (μg/L) (above the calibration range

of the instrument), 31 μg/L, and 26 μg/L, respectively. A second round of ground water sampling (Spring 1999) was conducted at PS-13 to confirm prior results and obtain a non-estimated concentration. Concentrations detected in the second round of sampling did not exceed MADEP's MCP RCGW-2 criteria. No historical information identified a source of chlorinated compounds at the Site.

Methyl *tert*-butyl ether, a component of gasoline, was also reported at 27 μg/L and 9 μg/L in ground water samples from PS-14 and PS-2, respectively, in the north-northeastern portion of the Site and at A-110 by ANI. The concentrations reported are between almost 2,000 and 5,500 times below the MCP GW-2 reportable concentrations. In addition, naphthalene was reported below the quantitation limit in ground water from PS-14 at 1 μg/L.

No TICs were identified in the VOC analyses for any ground water samples.

ANI's consultant submitted one ground water sample from PS-3 for VOC analysis. No VOCs or TICs were detected in this sample.

5.1.2.3 SVOCs

The Phase I Report contains a summary of compounds detected in ground water samples from the SVOC analyses. Results indicate that no compounds were reported above MCP RCGW-2 reportable concentrations.

All of the SVOCs detected in ground water are common laboratory contaminants. In addition, each reported concentration was estimated because it was detected below the instrument quantitation limits. There are no listed MCP reportable concentrations for dimethylphthalate and diethylphthalate. The concentrations of phenol reported range from approximately 7,300 to 34,000 times lower than the applicable MCP RCGW-2 reportable concentration for this compound. Therefore, no further investigation of SVOCs in ground water was recommended.

The Phase I Report contains a summary of compounds detected in ground water samples from the PAH analyses. Results indicate that no compounds were reported

above MCP RCGW-2 reportable concentrations. The highest concentrations of PAHs were reported in the ground water sample from PS-6. Relatively lower concentrations of PAHs were identified in the ground water sample from PS-7, just west of PS-6. In both cases, reported concentrations were approximately 33 to 40,000 times lower than the applicable MCP RCGW-2 reportable concentrations. (The soil samples from the borings for these locations did have elevated concentrations of PAHs reported.)

Some of the PAH compound concentrations reported in the ground water sample from PS-6 (i.e., benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, dibenz[a,h]anthracene, benzo[a]pyrene, and chrysene) exceeded the water solubility limits for the respective PAHs. In other words, the concentrations detected are higher than the concentrations of these compounds that can dissolve in water under standard conditions. This indicates that silt was present in the sample; PAHs present in silt can artificially elevate concentrations detected in unfiltered ground water samples. All but one of these compounds (dibenz[a,h]anthracene) was detected in subsurface soil at PS-6.

ANI's consultant collected five ground water samples for SVOC analysis (PS-2, PS-3, PS-4, PS-7, PS-8). No SVOCs or TICs were detected in these samples. Based on the results of testing by the City and ANI, no further investigation of PAHs in ground water was recommended.

5.1.2.4 Inorganics

The Phase I Report provided results of the analyses for PP13 and other inorganic parameters analyzed. Results indicate that, with the exception of nickel, all results were below applicable MCP RCGW-2 reportable concentrations. In 1998, nickel was detected above its MCP RCGW-2 reportable concentration in ground water from all wells except for PS-1, PS-6, and PS-7. In the second round of testing conducted in the spring of 1999, nickel was detected in all of the steel microwells, but was not detectable in the two new PVC wells. The PVC wells and two nearby metal wells were retested in June 1999. Similar results were obtained; again, nickel was not detected in the PVC wells. In general, there were no consistent patterns observed among ground water nickel concentrations and soil nickel concentrations, dissolved oxygen, or pH levels in ground

water. Therefore, it is interpreted that the source of the nickel is the steel casings of the microwells.

No trends in the sulfate results were identified in these samples.

The ground water analytical results summarized in this section and discussed in detail in the Phase I Report were utilized in the Method 3 Risk Characterization detailed in later sections of this Phase II Report. Results are included in Exposure Point Concentration (EPC) tables in Appendix N.

5.2 SOIL SAMPLING METHODS

This section describes soil sampling methods utilized during all Phase II assessment programs at Russell Field. In addition, Phase I sampling methods are summarized here. Results of these efforts are provided in Section 5.3.

5.2.1 Accessible Soil (0 – 3 feet below ground surface)

5.2.1.1 Previous Investigations—Phase I

The initial surficial soil sampling programs completed during Phase I investigations (December 1997 and February 1998) were conducted to determine if normal and expected use of the field posed any significant immediate health risks due to the potential presence of contamination in surficial soils. Samples were analyzed for asbestos, SVOCs, and inorganic analytes during these programs. Methods and results of the 1997 through 1998 surficial sampling programs were reported to the MADEP BWSC in a Phase I Site Assessment Report and Tier Classification submittal dated July 23, 1999. Refer to the Phase I Report for more detailed information regarding sample locations, zone boundaries, and sampling methodology. Sample locations from the Phase I investigations are included in Figures 2 and 6, Appendix C.

5.2.1.2 2002 CAO Compliance Assessment

From July 8, 2002 to July 16, 2002 (Summer 2002), an additional soil sampling program was conducted. These results were summarized in the April 2003 CAO compliance

assessment report. All results from this program are included with supporting documentation in this report. The primary focus of the sampling program was characterization of accessible soils located 0 – 3 feet below ground surface for asbestos content in compliance with the City of Cambridge Asbestos Ordinance (#1232). During the seven-day soil investigation program, 281 borings were advanced and soil samples were obtained for laboratory analysis. The soil samples collected during this program, combined with the results of previous testing, provides coverage for a 37.5-foot on center grid of samples over the entire Site (except where structures are located). In addition, deeper borings were completed in localized areas where deeper soils may be disturbed during proposed field renovation.

ANI and/or their representative (GeoInsight) was present at times throughout the seven-day program to observe the field activities and collect split samples. As ANI and GeoInsight's time on-site was limited, EH&E split archived samples after completion of the field program. In some cases, the amount of archived soils was limited; therefore, a split was not provided to GeoInsight. Soil sample splits were submitted to GeoInsight under chain of custody on October 7, 2002.

Of the 281 borings, approximately 62 were representative of shallow surficial soil and completed to depths of 1 foot or less below ground surface. Two hundred and nine shallow subsurface borings were completed from 0 – 2' or 3' in depth and 10 subsurface borings were advanced to depths greater than 3 feet below ground surface (Figure 2). Shallow surficial borings are designated as A-series and subsurface borings are designated as both A and B-series in Figure 2 and on boring logs in Appendix H. The Soil Boring Location Plan (Figure 2) illustrates approximate locations of all borings completed from July 8, 2002 through July 16, 2002, and additional borings completed during investigations conducted as part of Phase I.

Discrete samples from the topsoil and the underlying fill (if present) were collected from all of these borings and submitted for asbestos analysis. Soils from each major stratum, topsoil versus fill, were separated. Homogenized samples from each stratum were split for archival purposes and for ANI. Archived samples are kept for possible analysis at a later date. Soil boring logs indicate the depths of any strata changes and sample identifications.

A total of 222 of the 281 borings were advanced by PSA using two all-terrain vibratory soil sampling rigs (VibraDrill model H641). Continuous sampling techniques were conducted with four-foot long acetate-lined tube samplers. Samples obtained using vibratory drilling techniques were collected by vibrating a four-foot core barrel with an inner plastic sleeve in four-foot runs. The barrel was then removed and the sample was taken from the plastic sleeve. Samples collected from one foot or less below ground surface during the surficial sampling program were advanced by EH&E field staff using hand tools.

The boring logs in Appendix H provide soil classification information and detailed descriptions of anthropogenic materials present, such as coal or wood ash, cinders, "klinkers" or "coal-ash," or suspect asbestos materials, etc. Suspect ACM were not split nor broken, but sent intact as debris samples for laboratory analysis.

During the boring program, soil samples were sprayed with de-ionized water after removal from the acetate tube and during homogenization over the selected interval to reduce soil and debris from becoming airborne.

Sampling equipment was decontaminated between use at each boring. Decontamination methods included, in order, a Liquinox and distilled water scrub, a distilled water rinse, and air drying. Sampling devices were visually assessed for evidence of potential cross-contamination following cleaning and before each use.

Soils obtained from each location were screened with a photoionization detector (PID) to provide an initial indication of whether the sample contained VOCs. Soils were field screened with a Thermo 580-B PID equipped with a 10.6 electron-volt lamp for VOCs. The PID was calibrated daily in the field prior to use and, if conditions warranted, additional calibrations were conducted throughout the day.

During the 2002 sampling program, PID screening detected VOCs in only one soil boring, B-68, at concentrations that exceeded background. A gasoline-like odor was detected and, therefore, EH&E obtained soils from the intervals which indicated that VOCs were present above background (B-68 S1 and B-68 S2). Soil from B-68 S1 was submitted to Groundwater Analytical, Inc. (Groundwater Analytical) of Buzzard's Bay,

Massachusetts for analysis for volatile petroleum hydrocarbons (VPHs) via MADEP specified methodology. One asphalt-like debris sample from B-51 (B-51 S3) was submitted to Groundwater Analytical for analysis for polychlorinated biphenyls (PCBs) and extractable petroleum hydrocarbons (EPHs) with target compounds. Soil samples submitted to Groundwater Analytical for laboratory analysis are summarized in Table 5.1.

Table 5.1 Soil Samples Analyzed for Russell Field, Cambridge, Massachusetts by Groundwater Analytical Laboratories, Inc., Buzzard Bay, MA, July 8, 2002 through July 16, 2002

Type of Analysis	Total Samples Analyzed
MADEP VPH soil	1
PCBs	1
EPH and target analytes soil	1
Total of all samples	*3*

MADEP Massachusetts Department of Environmental Protection
VPH volatile petroleum hydrocarbon
PCB polychlorinated biphenyl
EPH extractable petroleum hydrocarbon

One soil sample held for MADEP VPH analysis.

Soil samples and debris samples collected for laboratory analysis for asbestos were couriered by a laboratory representative at the end of each day, under chain of custody, to ProScience Analytical Services, Inc. (ProScience), Woburn, MA. ProScience is accredited for asbestos analysis, as awarded by the American Industrial Hygiene Association, the National Voluntary Laboratory Accreditation Program (both air and debris), and the Massachusetts Department of Labor and Workforce Development.

All soil samples submitted by EH&E for analysis for asbestos to ProScience were analyzed for asbestos via the EPA Region 1 Protocol for Screening Soil and Sediment for Asbestos Content utilizing polarized light microscopy (PLM). Debris samples were analyzed via the EPA 600/R-93/116 method. In total, ProScience analyzed 597 soil and debris samples for asbestos via PLM. Of the 597 soil and debris samples submitted for analysis by PLM, 26 of those were also analyzed for asbestos via transmission electron microscopy (TEM) methods. Soil samples and debris samples analyzed by ProScience for asbestos are summarized in Table 5.2 below.

Table 5.2 Samples Analyzed for Russell Field, Cambridge, Massachusetts by Proscience Analytical Services, Inc., Woburn, MA. July 8, 2002 through July 16, 2002

Type of Analysis	Total Samples Analyzed
PLM soil	587
PLM debris	10
TEM soil reanalysis	26
Total of all samples	*597*

PLM polarized light microscopy
TEM transmission electron microscopy

Samples unanalyzed were subject to being overloaded with dust or other particulates.

Ten debris samples of anthropogenic materials encountered in soils during the boring program were submitted to ProScience for PLM analysis. These anthropogenic materials had the potential to be ACM and, therefore, were submitted for laboratory analysis of asbestos content. The depth at which these anthropogenic materials were collected can be found in the soil boring logs in Appendix H.

Results of the Summer 2002 sampling program are discussed in Section 5.3.

5.2.2 Subsurface Soil (>3 feet below ground surface)

5.2.2.1 Previous Investigations—Phase I

Preliminary subsurface programs were conducted in 1998. Samples were analyzed for asbestos, SVOCs, and inorganic analytes during these programs. Methods and results of the 1998 subsurface sampling programs were reported to the MADEP BWSC in a Phase I Site Assessment Report and Tier Classification submittal dated July 23, 1999. Refer to the Phase I Report for more detailed information regarding sample locations, zone boundaries, and sampling methodology. Sample locations are illustrated in Figure 2 and results are summarized in Section 5.3.

5.2.2.2 2002 CAO Compliance Assessment

Ten borings were advanced to depths greater than three feet during the Summer 2002 investigation (illustrated in Figure 2). Soil sampling and analytical methods are described

in Section 5.2.1.2. This assessment focused on characterization of the extent of asbestos in soil. Selected samples were also analyzed for EPHs and PCBs.

5.2.2.3 Geotechnical Program

The geotechnical program at Russell Field was conducted in May and June 2003. The program was not conducted for Massachusetts Contingency Plan nor Cambridge Asbestos Ordinance Compliance. The program was conducted by others as a geotechnical engineering study to provide recommendations regarding the proposed field house construction. EH&E provided on-site health and safety monitoring. EH&E also collected samples of soil and anthropogenic (man-made) materials for asbestos analysis, as necessary, based upon visual observations in the field. Figure 3 in Appendix C illustrates the approximate locations of the geotechnical borings (ESB series). The geotechnical assessment report (Weber Engineering Associates, LLC) and boring logs (EnviroSense, Inc.) are included in Appendix J.

During the geotechnical Site assessment program at Russell Field, conducted in May and June 2003 by EnviroSense, Inc., 12 borings were advanced approximately 26 feet or greater. Based upon field observations, 8 soil samples and 7 debris samples were obtained for laboratory analysis for asbestos. Soil samples and debris samples submitted to ProScience for laboratory analysis for asbestos are summarized below in Table 5.3.

Table 5.3 Soil and Debris Samples Analyzed for Asbestos—Russell Field, Cambridge, Massachusetts by Proscience Analytical Services, Inc., Woburn, MA, May 27 through June 5, 2003

Type of Analysis	Total Samples Analyzed
PLM soil	8
PLM debris	7
Total of all samples	*15*

PLM polarized light microscopy

Samples collected by EH&E May 27 through June 5, 2003 during the geotechnical assessment program.

5.2.2.4 2003 CAO Compliance Assessment

The primary focus of the sampling program conducted in November and December 2003 was further characterization of the extent of contamination in subsurface soils located 3 feet below ground surface or greater. Previous investigations generally provided coverage for a 37.5-foot on center grid of samples over the entire Site for shallow soil (0 – 3'), because field renovation was assumed to disturb shallow soil over much of Russell Field. Upon completion of field renovation plans, 202 additional soil borings to depths greater than 3 feet were completed in localized areas based upon anticipated soil disturbance activities during renovations at the Site. Samples were required at these locations and intervals to support CAO compliance. Locations for the installation of soil borings for the November/December 2003 program were selected based upon the proposed Brown, Richardson & Rowe design plans (October 2003) for field renovations.

EH&E collected archive samples and split samples for ANI through their consultant, GeoInsight. In some cases, the amount of split soils was limited; therefore, a split was not provided to GeoInsight. Soil sample splits were submitted to GeoInsight under chain of custody on December 2, 2003.

On November 18, 2003, EH&E's soil investigation began and continued during weekdays through December 2, 2003. During the nine-day soil investigation program, 202 borings were advanced by PSA and soil samples were obtained for laboratory analysis for asbestos. One hundred seventeen subsurface borings were completed from 0 to 5' in depth and 85 subsurface borings were advanced to depths greater than 5 feet below ground surface. The approximate locations of borings completed in November and December 2003 (designated as C-series) are illustrated in Figure 3 (Appendix C). Boring logs are included in Appendix I

During the sampling program in November and December 2003, discrete samples from the fill were collected from all of these borings and submitted for asbestos analysis. Soils from each major stratum, topsoil versus fill, were separated. Homogenized samples from each stratum were split for archival purposes and for ANI. Archived samples are kept for possible asbestos analysis at a later date. Soil boring logs indicate the depths of any strata changes and sample identifications.

PSA advanced the 202 subsurface borings using two all-terrain vibratory soil sampling rigs (VibraDrill model H641). Continuous sampling techniques were conducted with four-foot long acetate-lined tube samplers. Samples obtained using vibratory drilling techniques were collected by vibrating a four-foot core barrel with an inner plastic sleeve in four-foot runs. The barrel was then removed and the sample was taken from the plastic sleeve.

The boring logs in Appendix I provide soil classification information and detailed descriptions of anthropogenic materials present, such as coal or wood ash, cinders, "klinkers" or "coal-ash," or suspect asbestos materials, etc. Suspect ACM were not split nor broken, but sent intact as debris samples for laboratory analysis.

During the sampling program, soil samples were sprayed with de-ionized water after removal from the acetate tube and during homogenization over the selected interval to prevent soil and debris from becoming airborne.

Sampling equipment was decontaminated between use at each boring. Decontamination methods included, in order, a Liquinox and distilled water scrub, a distilled water rinse, and air drying. Sampling devices were visually assessed for evidence of potential cross-contamination following cleaning and before each use.

Soils obtained from each subsurface location were screened with a PID to provide an initial indication of whether the sample contained VOCs. Soils were field screened with a Thermo 580-B PID equipped with a 10.6 electron-volt lamp for VOCs. The PID was calibrated daily in the field prior to use and, if conditions warranted, additional calibrations were conducted throughout the day.

Soil samples and debris samples collected for laboratory analysis for asbestos were couriered by a courier service at the end of each day, under chain of custody, to Proscience, Woburn, MA. During the November/December 2003 program, all soil samples submitted by EH&E for analysis to ProScience were analyzed for asbestos via PLM using the EPA Region 1 Protocol for Screening Soil and Sediment for Asbestos Content. Debris samples were analyzed via the EPA 600/R-93/116 method. In total,

ProScience received 295 soil and debris samples for analysis for asbestos via PLM. Soil samples and debris samples submitted during the November/December 2003 sampling program for asbestos analysis are summarized in Table 5.4.

Table 5.4 Soil and Debris Samples Analyzed for Asbestos—Russell Field, Cambridge, Massachusetts by Proscience Analytical Services, Inc., Woburn, MA, November 18 through December 2, 2003

Type of Analysis	Total Samples Analyzed
PLM soil	285
PLM debris	10
Total of all samples	*295*

PLM polarized light microscopy

The ten debris samples submitted for PLM analysis represent anthropogenic materials discovered in soils during the boring program. This anthropogenic debris had the potential to be ACM and, therefore, were submitted for laboratory analysis of asbestos content. The depth at which these anthropogenic materials were collected can be found in the soil boring logs in Appendix I.

In addition to obtaining soil samples at each stratum and each boring location, additional soil samples were obtained and submitted for laboratory analysis for VPHs, EPHs, metals, and PAHs. Selection of samples to be submitted for laboratory analyses was based on the results of field VOC headspace screening, visual observations of soil type, soil staining, presence of foreign material, and boring location. Another objective was to obtain additional information for the risk characterization. Samples were kept under chain-of-custody procedures, stored on ice, and delivered by courier to Groundwater Analytical. The sample types submitted for analyses to Groundwater Analytical are summarized in Table 5.5.

Table 5.5 Samples Analyzed for Russell Field, Cambridge, Massachusetts by Groundwater Analytical Laboratories, Inc., Buzzard Bay, MA, November 18, 2003 through December 2, 2003

Type of Analysis	Total Samples Analyzed
MADEP VPH soil	3
EPH and target analytes soil	3
Metals	23
PAHs	26
Total of all samples	*55*

MADEP Massachusetts Department of Environmental Protection
VPH volatile petroleum hydrocarbons
EPH extractable petroleum hydrocarbons
PAH polycyclic aromatic hydrocarbon

Samples submitted to the laboratory that were unanalyzed were held for analysis if needed.

During the November/December 2003 sampling program, PID screening detected total VOCs in excess of background in three soil borings, C-95, C-96, and C-123. In addition to the PID screening results, petroleum-like odors were detected in the three samples. EH&E obtained soils from the intervals which indicated that total VOCs were present above background (C-95 S1P, C-96 S4P, and C-123 S1P) and submitted the soil samples to Groundwater Analytical for analysis for VPHs and EPHs with target compounds via MADEP specified methodology. Soils from soil boring location C-39 are characterized on the boring log (Appendix I) as having a very well-defined layer of incinerated debris with little coal ash. As a result of this observed well-defined layer of incinerated debris, EH&E obtained soils from C-39 and submitted the soil sample to Groundwater Analytical for analysis for PAHs.

Analytical results of samples obtained during the geotechnical assessment and the November/December 2003 soil sampling program are discussed in detail in Section 5.3.

5.3 SOIL SAMPLING RESULTS

This report section includes a summary of analyses of soil and debris samples obtained at Russell Field during all completed assessment programs. Analytical results from all Phase II sampling events are included in tables in Appendices D through G. Data obtained during the Phase I assessment are also discussed in this section and are included in the EPC tables in Appendix N.

Laboratory reports are included in Appendices K and L.

5.3.1 Asbestos Results

5.3.1.1 Asbestos in Soil

Throughout the CAO and geotechnical assessment programs (2002 through 2003), ProScience received a total of 881 soil samples to be analyzed for asbestos via PLM. Of the 881 soil samples submitted for PLM analysis, 26 were reanalyzed for asbestos via TEM and 14 were reanalyzed for asbestos via PLM. TEM reanalysis was only performed on 26 of the 588 samples submitted as part of the Summer 2002 sampling program. TEM analysis was not performed on any soil samples submitted for analysis during the geotechnical assessment or the November/December 2003 sampling program. Twenty duplicate samples were submitted for analysis.

Reanalysis of the 14 soil samples via PLM was conducted during the Summer 2002 sample program to check variability of PLM analysis methods for soils at the Site. PLM reanalysis was conducted on 14 soil samples where positive results for asbestos were found. Results of PLM reanalysis for the 14 samples submitted in Summer 2002 detected asbestos in only two soil samples. This is likely due to the inherent heterogeneity of soil samples and analytical limitations. Table D.1 Appendix D summarizes these results and includes information on the sample locations and depth.

ANI analyzed a total of 17 split samples for analysis by PLM. Asbestos was detected at trace levels (<1%) at two locations (B-205 S1, B-166 S2). Trace levels were also detected by EH&E at these locations. ANI laboratory reports are included in Appendix L.

Based upon the results of PLM analysis of soils submitted Summer 2002, EH&E selected 26 soil samples for TEM analysis. This included all fourteen samples containing detectable asbestos by PLM and 12 samples in which asbestos was not detected. TEM analyses were run on samples obtained during the Summer 2002 sampling program to compare alternate analytical methods and to respond to a request by ANI. Trace concentrations (<1%) of asbestos were detected in 13 samples (Table D.2 Appendix D)

via TEM analysis. Ten of these samples corresponded to samples with trace levels of asbestos detected by PLM.

Trace levels of asbestos (<1%) were detected in soils obtained from the Site at 24 of the 881 soil samples submitted throughout the Phase II assessment programs. Tables D.3 and D.4 in Appendix D summarize the results of asbestos analysis and include information on the sample location and depth for soil samples analyzed via PLM and TEM analysis obtained during the Summer 2002 through December 2003 sampling programs. Laboratory reports from the soil sampling programs are located in Appendix J.

During Phase II, 6 of the 24 sampling locations with trace levels of asbestos (<1%) were obtained from depths of 0 – 3 feet below asphalt in the parking lot, 1 sample obtained from the parking lot at a depth greater than 3 feet also had trace levels of asbestos detected. Soils beneath the parking lot have the highest frequency of trace level asbestos detection. Seven trace level samples were obtained at locations covered by vegetation from depths between 0 and 3 feet below ground surface. An additional 4 locations with trace levels of asbestos were obtained from vegetated locations at depths ranging from greater than 1 foot below ground surface to 3 feet. The remaining 6 locations with trace levels of asbestos are located at depths greater than 3 feet below ground surface.

As reported in the Phase I Report, trace levels of asbestos were detected by PLM in nine additional locations during the 1998 and 1999 sampling programs. All of these trace detections identified during Phase I were from locations at least one foot below the ground surface or root zone (where present), or below asphalt. The nine locations identified in the Phase I as having trace (<1%) levels of asbestos in soil are: PS-4, PS-5, PS-12, GA, A-27, A-29, A-101, A-104, and A-114. GA was originally referred to as the Garden Area based upon early renovation plans; no garden areas are currently planned at the Site.

Therefore, the total number of locations with trace level detections of asbestos (<1%) in soil is 33, based upon all sampling rounds and including both PLM and TEM results. Only seven of these detections are located at depths of less than one foot and not below

asphalt. Six of these locations are vegetated. The remaining detection occurred at a depth greater than eight inches.

Concentrations of asbestos in soils exceeding 1% (by PLM) were only detected at 3 locations (PS-2, PS-6, PS-14) during the Summer 1998 sampling event and one location (C-150 S1) during the November/December 2003 sampling event. The samples obtained in Summer 1998 were collected from the fill by GeoInsight as composites from depths of 2 – 5 feet. The sample obtained at the C-150 S1 location was a composite from a depth of 3 – 4.5 feet.

The four soil sample locations (PS-2, PS-6, PS-14, and C-150) with concentrations exceeding 1% are subject to regulation under the CAO and will be remediated prior to initiation of soil-disturbing renovation activities.

ANI did not analyze any split samples from the November 2003 through December 2003 soil sampling program; therefore, no additional results are reported here.

Figure 7 in Appendix C is a Site map identifying locations where asbestos has been detected in soil and debris at the Site.

Archived soil samples were submitted for additional analyses to support risk characterization. The nature and results of these samples and analyses are discussed in detail in Section 7.4 of the risk characterization.

5.3.1.2 Asbestos in Debris Samples

A total of 27 debris samples obtained during Summer 2002 through December 2003 sampling programs and the geotechnical program were submitted for asbestos analysis by PLM. Results of these analyses are included in Appendix D, Table D.5.

Asbestos was detected at trace levels (<1%) in three of the 27 debris samples and at concentrations greater than 1% in 3 additional samples. Trace levels (<1%) of asbestos were detected in debris samples submitted from soil boring locations A-11 S3, ESB-11, and C-37 S1. The debris sample obtained from ESB-11 was found at a depth of

approximately 8 inches beneath ground surface. The debris sample from soil boring location C-37 S1 was obtained from a depth of 4.5 feet beneath ground surface, and debris sample A-11 S3 was obtained from a depth of 3 to 12 inches beneath ground surface. It is notable that soil from around the debris sample obtained at C-37 S1 did not contain detectable concentrations of asbestos by PLM.

Analyses of 3 of the 27 debris samples submitted to ProScience indicated the presence of asbestos at concentrations in excess of 1%. These locations will be remediated in conjunction with planned Site renovations and in accordance with the MCP and other applicable regulations. Debris samples obtained from ESB-2 (14 inches below ground surface) and ESB-11 (at 12 inches below ground surface) during the geotechnical program detected concentrations of chrysotile asbestos at 20 percent and 35 percent, respectively. It is notable that soil surrounding the debris samples obtained from the same locations (ESB-2 at 14 inches below ground surface and ESB-11 at 12 inches below ground surface) did not contain detectable concentrations of asbestos by PLM.

One sample of anthropogenic material which was obtained from a depth of 12 inches beneath ground surface from location A-25 during the Summer 2002 sampling event resulted in chrysotile asbestos detection at 45%. It is notable that soil from that location (A-25 S2) did not contain detectable concentrations of asbestos by PLM (analyzed twice by that method) and only trace concentrations were detected in soil by TEM. This location will also be remediated in accordance with the MCP and other applicable regulations.

Figure 7 in Appendix C illustrates the locations where asbestos was detected in soil and/or debris samples during these and previous investigations.

5.3.2 Organic Analyses

5.3.2.1 VOCs

During the Phase I investigation, naphthalene was the only VOC detected at concentrations above the MADEP Reportable Concentration for Soil Category 1 (RCS-1). Exceedances of this criterion were observed at PS-8 and PS-11 in 1998. This compound was also detected in SVOC analyses.

Analytical results for VOC compounds in soil samples obtained during Phase I activities are detailed in the Phase I Report and included in EPC tables in Appendix N.

During the Summer 2002 sampling event, one sample, B-68 S1 was analyzed for VPHs with target compounds. Laboratory analytical results indicate that VPHs and target compounds were not detected in this sample above the laboratory reporting limit.

During the November/December 2003 sampling program, three samples, C123-S1P, C95-S3P and C96-S4P, were analyzed for VPHs with target compounds. No VPHs nor target compounds were detected above the MADEP RCS-1 in these samples. Results of VPH analyses for samples submitted November through December 2003 are summarized in Table E.2 Appendix E.

5.3.2.2 SVOCs

During the 1998 Phase I investigation, naphthalene was detected above the reportable concentration as an SVOC at PS-8 and PS-11; this compound can be detected by both VOC and SVOC analytical techniques. Results of SVOC analysis of subsurface soils are listed in the Phase I Report.

Concentrations of a number of PAHs exceeded reportable concentrations at seven of the seventeen locations tested during Summer 1998 sampling (PS-2, PS-4, PS-6, PS-8, PS-11, PS-12, PS-13). Six additional samples at five locations collected in Spring 1999 contained concentrations of PAHs that exceeded reportable concentrations (A-102, A-104, A-105, A-109, A-27). PAH concentrations observed at PS-4 and GA may be associated with coal or klinkers observed in these borings. Neither the naphthalene nor the PAH exceedances form a distinct pattern, but are somewhat scattered across the field in fill.

During Summer 1998 sampling, ANI's consultant (GeoInsight) collected split samples at PS-4, PS-8, and PS-11; these samples were analyzed for SVOCs only. ANI's results confirm the exceedance of the reportable concentration for naphthalene at PS-8 and

exceedances for various PAHs at PS-4. Summaries of ANI's results for Phase I testing may also be found in the Phase I Report.

During the Summer 2002 sampling event, a soil sample obtained from boring B-51 at a depth of 24 inches was analyzed for EPHs with target compounds and PCBs (sample ID B51-S3). Concentrations of EPH ranges for sample B51-S3 were detected at concentrations exceeding MADEP reportable concentrations. Results of EPH analysis from soil samples obtained Summer 2002 are included in Table E.1 in Appendix E. PCBs were not detected at concentrations in excess of the laboratory reporting limit for this sample.

PAH samples were not obtained for laboratory analysis during the Summer 2002 or geotechnical assessment programs.

Laboratory data reports for Summer 2002 are included in Appendix J.

During the November/December 2003 sampling event, three samples, C95-S3P, C96-S4P, and C123-S1P, were analyzed for EPHs with target compounds. Results of EPH analyses are included in Table E.3 in Appendix E. Four EPH target compounds were detected in sample C123-S1P at concentrations that exceeded the MADEP RC. The analytes detected above the MADEP RCs are: benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene. Two samples (C123-S1P and C95-S3P) contained concentrations of aliphatic and aromatic hydrocarbon ranges in excess of MADEP RCS-1. Soil samples with exceedances of MADEP RCS-1 standards were obtained at depths greater than two feet below ground surface. Locations with concentrations exceeding RCs are included on Figure 8.

PCB analyses were not requested for soil samples submitted during the November/December 2003 sampling program.

Laboratory analytical data for samples obtained during the November/December 2003 sampling round are included in Appendix J.

During the November/December 2003 sampling period, Groundwater Analytical analyzed 26 soil samples for PAHs. Of the 26 samples, only three soil samples submitted for PAH analysis (C-2 S1P, C-39 S1P, and C-123 S1P) exceeded the MADEP MCP RC (Figure 8). PAH analytical results are summarized in Tables E.4 through E.6 in Appendix E. Soil samples for location C-39 S1P were obtained at a depth of 0.5 to 8.5 feet below ground surface. Soil boring logs for this sample describe soils within this sample interval as containing anthropogenic waste materials such as a coal ash and klinkers.

5.3.3 Inorganic Analytes

Results of soil analysis for metals and other inorganic analytes obtained during the Phase I Site Assessment are documented in the Phase I Report. No cyanide was detected at the field. Concentrations of lead exceeded the reportable concentration at two locations, PS-4 and PS-6. In addition, concentrations of nickel and copper exceeded reportable concentrations at PS-4. Observed concentrations of metals at PS-4 may be related to the presence of klinkers reported in this boring. Beryllium was detected in the GA composite at a concentration slightly above the RCS-1 standard, and at other locations across the Site at lower concentrations. These locations are illustrated on Figure 8.

No exceedances of reportable concentrations of metals were detected in soils sampled in the spring 1999 sampling round.

Laboratory analytical data reports and tables associated with soil sample activities from 1998 through 1999 are included in the Phase I Site Assessment Report. This data is also included in the EPC tables in Appendix N.

Soil samples obtained during Summer 2002 and the geotechnical assessment in May of 2003 did not include analyses for metals.

During the November/December 2003 soil sampling program, 23 soil samples were submitted for laboratory analysis for PP13 via EPA SW-846. Analytical results indicate

that 3 of the 26 samples analyzed had concentrations of metals in excess of MADEP RCS-1 standards.

Lead was detected at C2-S1P and C21-S1P at concentrations of 710 micrograms per kilogram (μg/kg) and 400 μg/kg, respectively. These concentrations of lead are in excess of the MADEP RCS-1 of 300 μg/kg.

Tables F.1 through F.2 in Appendix F summarize analytical results for soil samples analyzed for PP13. Laboratory analytical data sheets are included in Appendices J and K.

Figure 8, Appendix C, shows soil sample locations where analytical results indicated exceedances of the MADEP RCS-1 criteria for metals, SVOCs, and EPHs. In general, these exceedances occurred in fill at the Site and are scattered throughout the property.

5.4 AIR SAMPLING

5.4.1 1999 Background Air Monitoring Program

Typical concentrations of airborne asbestos in urban settings have been reported to be approximately 0.0001 fibers per cubic centimeter (f/cm^3) and have been reported to range to 0.001 f/cm^3 phase contrast microscopy equivalent (PCME) (ATSDR 1995). The size fraction reported is typically greater than 5 microns. Studies assessing asbestos concentrations associated with urban traffic and braking have reported concentrations in the range of 0.0002 – 0.0004 f/cm^3 (Jaffrey 1990).

Some criteria have been established for asbestos exposure. The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for asbestos exposure in an occupational setting is 0.1 f/cm^3 and is based upon measurement of fibers greater than 5 microns in length (OSHA 29CFR1910). This is a health-based standard. The clearance level for indoor environments, including schools, after an asbestos abatement is 0.010 f/cm^3 (any fibers) based upon PCM analysis. Alternatively, clearance levels can be based upon comparison of at least five samples collected inside and outside of the work area, or upon the sample area average measure of less than 70

structures/square millimeter (method background). This standard, developed by EPA, does not discriminate by size and utilizes TEM analysis.

The objective of this Russell Field investigation was to assess concentrations of asbestos in air under relatively dry field conditions with typical field use activities.

5.4.1.1 Methods

Twenty-five air samples from twenty-one locations were collected on August 25, 1999 and submitted for analysis. A modified EPA Level II analysis (which utilizes TEM) was requested from EMSL of New Jersey. The laboratory holds Massachusetts certification for asbestos analysis. The method was modified to achieve a lower detection limit (0.0001 f/cm^3) and to allow differentiation between fibers greater than or less than 5 microns in length. The lower detection limit was requested to allow comparison to literature values for background asbestos concentrations in urban ambient air.

EH&E used the MoisturePoint 917 single diode probe to monitor soil moisture levels at Russell Field. The MoisturePoint 917 uses time domain reflectometry (TDR) as its method of determination of water content. TDR interprets the rising edge of an electromagnetic pulse sent along the probe. The propagation time of the electromagnetic signal is related to the water content of the medium. Generally, the readings have an accuracy of ±3% and a resolution of 0.1%. However, because a specific calibration was conducted at the factory based on soil types at Russell Field, accuracy was improved to ±1.3%.

Wind conditions were variable on the day of sample collection. Based on National Weather Service data for Bedford and Boston, wind speeds ranged from less than 5 to less than 15 knots. Wind direction was predominantly from the South/Southwest and ranged from Southeast to Southwest.

5.4.1.2 Results

Figure G.1 (Appendix G) illustrates air and soil moisture monitoring locations. As indicated in Table G.1 (Appendix G), soil moisture conditions on the day of testing generally ranged between 10 and 15% by the end of the day. The field had not been

irrigated for approximately six days prior to sampling (beginning the morning of August 19, 1999), but it did rain three to four days prior to sampling (August 21, 1999—0.16"; August 22, 1999—0.01"). Observed soil moisture conditions during sampling, on average, were the driest observed during the eight days of soil moisture testing conducted by EH&E in August 1999. Based on the soil moisture results and the fact that the field is typically irrigated, it is likely that, to achieve lower moisture levels (10% on average), it would be necessary to stop irrigation for an extended period of time, which would risk damage to the field. The soil moisture levels during testing of the air for asbestos were assumed to be drier than typical conditions when irrigation occurs more regularly.

Air monitoring results for samples collected on August 25, 1999 are provided in Table G.2 (Appendix G), and the analytical report is included in Appendix M. No asbestos was detected in 23 of the 25 locations sampled. The detection limit for this analysis was 0.0001 f/cm^3. Two samples, locations 6 and 7, contained low concentrations of asbestos, at or near the detection limit. The concentrations observed, 0.0001 and 0.0003 f/cm^3, are within the range of typical urban background, and well below any existing standards for occupational exposure or clearance levels for schools. While these standards are not directly applicable for users of Russell Field, they do provide a useful comparison.

A perimeter survey was conducted on the day of sampling. No active sources of asbestos generation were observed other than roadway traffic. Examples of potential sources that could have been observed include excavation or demolition activities on the field or nearby properties.

5.4.2 Air Monitoring—2002 and 2003 Assessment Programs

EH&E conducted air monitoring at Russell Field during the Summer 2002 (six days total), Summer 2003 (seven days total), and Fall 2003 (seven days total) sampling programs when weather conditions allowed. The air monitoring programs were conducted to assess potential impacts to workers and the surrounding community during the investigations and were the basis for additional Imminent Hazard Assessment at the Site. The objective was to assess concentrations of asbestos in air during soil sampling

activities. Access by the public was not allowed in work areas, which were marked with flagging at the beginning of the day and monitored by Site personnel.

5.4.2.1 Methods

Meteorological data were collected during sampling periods using a Davis Weather Monitor II. This unit was used to collect continuous data on wind direction, wind speed, and temperature. Information from the weather station was downloaded at regular intervals and recorded. At times when technical difficulties prevented data logging features, EH&E obtained and recorded information from the station approximately every hour. The weather station was set up at locations open to the wind and proximal to the work area.

Air samples were collected onto 25-millimeter diameter, open-faced air sampling cassettes. The cassettes were equipped with conductive extension cowls to minimize fiber losses due to electrostatic effects. The filter media were 0.8-micron pore size, mixed cellulose ester filters.

The samples were collected using high volume air sampling pumps. Flow rates for the various pumps generally ranged from 10 to 13 liters per minute. A rotometer, calibrated against a primary standard, was used to check flow rates in the field. The sampling method and analysis techniques followed the requirements established by the National Institute for Occupational Safety and Health (NIOSH) and OSHA.

After sampling, the filter cassettes were sealed and sent to ProScience for fiber analysis and counting. The air samples were analyzed by the PCM technique. The total fiber count was determined using NIOSH Method 7400, entitled *Fibers*, and published in the NIOSH manual of Analytical Methods, Third Edition, Second Supplement, August 1987.

For comparative purposes, selected samples were reanalyzed for asbestos fibers by TEM via NIOSH Method 7402. Filters submitted to ProScience that were heavily loaded with pollen or dust due to local conditions were not analyzed by TEM. TEM analysis requires lighter loading of cassettes than PCM analysis. In the event that filters received were overloaded, ProScience verbally reported conditions to EH&E.

Air monitoring stations were set out at the beginning of each day. The air monitoring station locations were chosen daily depending upon prevailing wind directions and areas where sampling activities were taking place. Up to five of the air monitoring stations were stationary and set upwind and downwind of the sampling areas. If the prevailing wind direction changed, monitoring stations were moved to account for the upwind and downwind change. Air sampling stations were relocated if deemed necessary due to wind conditions or work area movement.

Each day, upwind, downwind, and workstation air samples were collected. Workstation samples included a stationary sampling station downwind of the sample handling area.

5.4.2.2 Results

Appendix G (weather data) provides a summary of meteorological conditions at Russell Field during the sampling programs. Tables G.1 through G.4 provide tabulated summaries of weather conditions observed during these programs. This data was used to interpret upwind and downwind conditions. Meteorological conditions were collected daily on-site at Russell Field. Average temperature and average wind speed were obtained from daily weather collected at the National Climatic Data Center, Boston Logan International Airport, Boston, MA.

Air monitoring results by PCM analysis are provided in Tables G.5 through G.7, G.9 through G.25, and G.27 in Appendix G for all three sampling programs. Analytical reports for asbestos air sampling data are included in Appendix J. PCM provides a measure of total fibers in a sample, not just asbestos fibers. The method detection limit for this analysis was 0.001 f/cm^3, although higher sample volumes provided lower detection limits for some samples. The concentrations of total fibers observed were within the range of typical urban concentrations for asbestos fibers, and well below any existing standards for occupational exposure or clearance levels for schools. While these standards are not directly applicable for users of Russell Field, they do provide a useful comparison. Further, upwind and downwind concentrations at the field were similar. More importantly, EPCs (using the approach described in Appendix G) do not constitute an Imminent Hazard as defined by the MCP. The action level of 0.003 total

f/cm^3 (downwind minus upwind concentration) was not exceeded during the monitoring programs at Russell Field.

Results of reanalysis by TEM of samples collected on July 10, 2002 and December 1, 2003 are provided in Tables G.8 and G.26 in Appendix G. The analytical reports are also included in Appendix J. No asbestos fibers were detected in any of the samples analyzed by TEM. Results of these analyses further support the Imminent Hazard assessment approach and findings.

An action level of 0.003 total f/cm^3 was developed for the sampling program. If it had been exceeded, work would have stopped and samples for the day that the exceedance occurred would have been reanalyzed via TEM analysis. No exceedances were detected.

Work area monitoring stations were subject to OSHA PELs. Therefore, the action level for worker safety is 0.10 asbestos fibers per milliliter (f/ml). All measured fiber and asbestos concentrations were below this limit.

5.5 ANALYTICAL SUMMARY

Table 5.6 summarizes the maximum and minimum concentrations detected in soil and Table 5.7 summarizes maximum and minimum concentrations detected in ground water samples collected at Russell Field. These tables also contain data on frequency of detection for each compound, including the total number of samples for each compound. Soil samples include surface and subsurface results. Not all samples collected were analyzed for all parameters listed, as described in detail in the preceding sections of this report.

Table 5.6 Maximum and Minimum Concentrations Detected in Soil at Russell Field

Compound	Maximum Soil Concentration		MADEP RCS-1	UCLs	Minimum Soil Concentration (mg/kg)	Detection Frequency (# detects/total # samples)
	Location	(mg/kg)				
Inorganics						
Antimony	Zone 10	6.3	10	400	BDL	3/40
Arsenic	C199-S1P	20	30	300	1.2	50/51
Beryllium	Garden	0.84	0.7	30	BDL	23/53
Cadmium	PS-4	2.1	30	800	BDL	27/51
Chromium	PS-6	32	1,000	10,000	BDL	36/51
Copper	PS-4	10,000	100	NS	BDL	45/58
Lead	PS-6	1,300	300	6,000	BDL	51/58
Mercury	C82-S1P	0.39	20	600	BDL	33/51
Nickel	PS-4	310	300	7,000	BDL	43/58
Selenium	Garden	0.85	400	10,000	BDL	2/51
Silver	PS-4	6.7	100	2,000	BDL	16/51
Zinc	PS-4	580	2,500	10,000	BDL	38/52
VOCs						
Acetone	A-102	0.640	3	10,000	0.017	18/18
Benzene	PS-6	0.004	10	2,000	BDL	6/20
Bromomethane	PS-5, 12	0.001	3	7,000	BDL	2/18
2-Butanone	PS-12-Dup	0.036	0.3	NS	BDL	16/18
sec-Butylbenzene	A-102	0.130	NS	NS	BDL	1/18
Carbon Disulfide	PS-11	0.003	100	NS	BDL	7/18
Chloroform	PS-3	0.004	0.1	5,000	BDL	9/18
Chloromethane	PS-10	0.003	100	NA	BDL	3/18
cis-1,2-Dichloroethene	PS-13	0.005	2	5,000	BDL	3/18
Ethylbenzene	PS-8	0.003	80	10,000	BDL	1/20
2-Hexanone	PS-7	0.001	100	NA	BDL	1/18
p-Isopropyltoluene	A-102	0.170	100	NS	BDL	3/18
Methyl Isobutyl Ketone	PS-8	0.001 (J)	0.5	10,000	BDL	1/18
Methyl *tert*-butyl Ether	PS-4	0.001 (J)	0.3	5,000	BDL	1/20
Methylene Chloride*	PS-1, 3, 8, 9, 10, 11, 13	0.003 (JB)	100	7,000	BDL	BDL*
Tetrachloroethene	PS-13	0.087	0.5	1,000	BDL	6/18
Toluene	PS-2, 12, 11	0.002 (J)	90	10,000	BDL	7/20
Trichloroethene	PS-13	0.008	0.4	10,000	BDL	4/18
Trichlorofluoromethane	PS-10, 2	0.001 (J)	1,000	NS	BDL	2/18
1,2,4-Trimethylbenzene	A-102	0.300	1,000	NS	BDL	2/18
1,3,5-Trimethylbenzene	A-102	0.200	10	NS	BDL	2/18
m,p-Xylene	PS-8	0.003	500	10,000	BDL	3/20
o-Xylene	A-102	0.039 (J)	500	10,000	BDL	2/20
SVOCs						
Acenaphthylene	PS-6	1.7 (JD)	100	10,000	BDL	21/103
Acenaphthene	C39-S1P	76	20	10,000	BDL	15/103
Anthracene	C39-S1P	97	1,000	10,000	BDL	41/103
Benzo(a)anthracene	C39-S1P	**170**	0.7	100	BDL	69/103
Benzo(a)pyrene	C39-S1P	**150**	0.7	100	BDL	68/103
Benzo(b)fluoranthene	C39-S1P	95	0.7	100	BDL	66/103
Benzo(g,h,i)perylene	C39-S1P	77	1,000	10,000	BDL	44/103
Benzo(k)fluoranthene	C39-S1P	110	7	400	BDL	65/103
bis-(2)-Ethylhexylphthalate	PS-11	0.5	100	10,000	BDL	19/41
Carbazole	PS-2	1.2 (JD)	NS	NS	BDL	21/41
Chrysene	C39-S1P	180	7	400	BDL	70/103
Dibenzo(a,h)anthracene	C39-S1P	28	0.7	100	BDL	8/103

Table 5.6 Continued

Compound	Maximum Soil Concentration Location	Maximum Soil Concentration (mg/kg)	MADEP RCS-1	UCLs	Minimum Soil Concentration (mg/kg)	Detection Frequency (# detects/total # samples)
Dibenzofuran	PS-2	1.2 (JD)	100	NS	BDL	6/41
Di-n-Butylphthalate	PS-7	0.26 (J)	50	NS	BDL	2/41
Fluoranthene	C39-S1P	330	1,000	10,000	BDL	73/103
Fluorene	C39-S1P	64	400	10,000	BDL	16/103
Indeno(1,2,3-cd)pyrene	C39-S1P	68	0.7	100	BDL	45/103
2-Methylnaphthalene	PS-2	0.78 (JD)	4	10,000	BDL	16/102
4-Methylphenol	PS-12	0.061	500	NS	BDL	1/40
Naphthalene	PS-8	47	4	10,000	BDL	48/105
n-C_9 to n-C_{18} Aliphatic Hydrocarbons	C123-S1P	33	1,000	20,000	BDL	1/3
n-C_{19} to n-C_{36} Aliphatic Hydrocarbons	C123-S1P	1,700	2,500	20,000	BDL	2/3
n-C_{11} to n-C_{22} Aromatic Hydrocarbons	C123-S1P	460	200	10,000	BDL	2/3
Phenanthrene	C39-S1P	470	100	10,000	BDL	70/103
Pyrene	C39-S1P	450	700	10,000	BDL	72/103

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration, Soil Category 1
MCP Massachusetts Contingency Plan
UCL Upper Concentration Limit
mg/kg milligrams per kilogram
BDL results below detection limits
NS no standard
(J) estimated value, below quantification limit
(B) found in associated blank as well as sample
(D) diluted sample

Boldface type indicates UCL exceedance.

* Methylene chloride—all samples BDL or low levels with detection in blank; interpreted as laboratory contamination.

Table 5.7 Maximum and Minimum Concentrations Detected in Ground Water at Russell Field

Compound	Maximum Water Concentration		MADEP RCGW-2 (mg/L)	UCLs (mg/L)	Minimum Water Concentration (mg/L)	Detection Frequency (# detects/total # samples)
	Location	(mg/L)				
Inorganics						
Arsenic	PS-11	0.11	0.4	4	BDL	5/14
Chromium	PS-4	0.1	2	20	BDL	3/14
Copper	PS-4	0.013	100	NS	BDL	1/14
Nickel	PS-5	0.74*	0.08	1	BDL	BDL*
Selenium	PS-3	0.002	0.08	0.8	BDL	1/14
Zinc	PS-2	0.062	0.9	20	BDL	10/14
VOCs						
Chloroform	PS-6	0.005	0.4	100	BDL	3/14
cis-1,2-Dichloroethene	PS-13	0.031	30	100	BDL	3/14
Methyl *tert*-butyl Ether	PS-14	0.027	50	100	BDL	2/14
Tetrachloroethene	PS-13	0.470	3	100	BDL	3/14
Trichloroethene	PS-13	0.026	0.3	100	BDL	1/14
SVOCs						
Acenaphthylene	PS-6	0.00068**	3	30	BDL	BDL**
Anthracene	PS-6	0.00063**	0.6	30	BDL	BDL**
Benzo(a)anthracene	PS-6	0.003**	3	30	BDL	BDL**
Benzo(a)pyrene	PS-6	0.002**	3	30	BDL	BDL**
Benzo(b)fluoranthene	PS-6	0.0032**	3	30	BDL	BDL**
Benzo(g,h,i)perylene	PS-6	0.0024**	3	30	BDL	BDL**
Benzo(k)fluoranthene	PS-6	0.0027**	3	30	BDL	BDL**
Butyl benzyl phthalate	PS-10	0.001 (J)	10	NS	BDL	1/14
Chrysene	PS-6	0.0035**	3	30	BDL	BDL**
Dibenzo(a,h)anthracene	PS-6	0.00038**	3	30	BDL	BDL**
Diethylphthalate	PS-5	0.004 (J)	0.03	60	BDL	6/14
Dimethylphthalate	PS-5	0.00058 (J)	0.03	100	BDL	1/14
Fluoranthene	PS-6	0.0056**	0.2	3	BDL	BDL**
Indeno(1,2,3-cd)pyrene	PS-6	0.0026**	3	30	BDL	BDL**
Naphthalene	PS-14	0.00026	6	60	BDL	4/14
Phenanthrene	PS-6	0.0015**	0.05	3	BDL	BDL**
Pyrene	PS-6	0.0064**	3	30	BDL	BDL**
Phenol	PS-10	0.0041 (J)	30	100	BDL	10/14

MADEP Massachusetts Department of Environmental Protection
RCGW-2 Reportable Concentration, Ground Water Category 2
UCL Upper Concentration Limit
mg/L milligrams per liter
BDL results below detection limits
(J) estimated value, below quantification limit
(B) found in associated blank as well as sample

* Attributed to well construction; see text.
** Attributed to silt in sample; see text.

Results of extensive testing of surface soil (0 to 6") did not detect SVOCs or metals at concentrations exceeding reportable concentrations except in one composite sample

(Zone 10). Retesting of discrete samples from this zone did not detect any exceedances at this location.

Exceedances of reportable concentrations of PAHs and some metals were detected in some subsurface soil samples in fill at varying depths. The occurrence of these exceedances does not form a distinct pattern, but are scattered across the field. At C39, concentrations of two PAHs (benzo(a)anthracene and benzo(a)pyrene) exceeded the Upper Limit Concentrations (UCLs).

Asbestos was also detected in some subsurface soil and debris samples in fill at Russell Field and, as with the exceedances of PAH and metals concentrations, detection of asbestos does not form a distinct pattern. Asbestos was detected at concentrations greater than 1% at seven locations in subsurface soil or debris at depths of at least one foot. Therefore, risk of exposure during normal use of the field is minimal. The heterogeneity of soil quality across Russell Field is typical of urban fill.

Results of analysis of soils are further evaluated in Section 7.0, Public Health Risk Characterization. In order to effectively evaluate current and potential future exposure scenarios, EPCs are calculated based upon depth. This approach is discussed more fully in Section 7.0 and demonstrated in the EPC tables in Appendix N.

No exceedances of reportable concentrations for VOCs or SVOCs were detected in ground water at Russell Field. Nickel exceedances were only detected in metal wells at the Site; nickel concentrations in PVC wells at Russell Field were at or below detection limits. Therefore, the metal wells were interpreted to be the source of nickel in ground water samples collected at Russell Field. The concentrations of nickel observed did not constitute a reportable release in accordance with 310 CMR 40.0317 (14).

6.0 TRANSPORT AND FATE

The following sections describe the environmental transport and fate for Contaminants of Concern (COCs) at the Russell Field Site. These contaminants have been detected primarily in soils in fill at the Site and, if present in ground water, are present at concentrations well below MADEP reporting criteria. All routes of exposure, including exposure to ground water are considered in the risk characterization for Russell Field (Section 7.0), even though ground water is not considered a significant transport pathway for contaminants at this Site. Direct exposure to soil and soil as fugitive dust are the most significant exposure pathways. Because concentrations in ground water are below RCs (and, therefore, GW-3 Clean-up Standards), ground water at the Site is not interpreted to pose a significant risk to environmental receptors if it discharges to local surface water bodies. Exposure pathways and receptors for the Site are discussed in detail in Section 7.2, Exposure Assessment, and Section 8.0, Environmental Risk Characterization.

6.1 ASBESTOS

Asbestos is a generic term used to describe a group of different types of hydrated, crystallized silicate minerals, all of which possess the attribute of breaking down into individual or groups of fibers. Asbestos minerals are chemically stable and long-lived in the environment.

Asbestos fibers are characterized by their length-to-width ratio. To be identified as fibers, this ratio must be at least 3:1. Several commonly used analytical techniques focus on fibers at least 5 microns in length, and occupational standards for airborne asbestos are based upon measurements of fibers greater than 5 microns in length. Evidence suggests that longer, thinner fibers are associated with greater carcinogenic risk. Occupational exposure to asbestos is known to cause lung cancer, mesothelioma (cancer of the chest or abdominal lining), asbestosis (non-malignant fibrosis), and non-malignant pleural disease. As such, the primary route of exposure that poses health risk is inhalation.

Major uses of asbestos include floor tiles, asbestos cements, thermal and acoustical insulation, plaster, roofing products, shingles, and friction products such as motor vehicle

brake shoes. Most of these products can be found in many types of buildings—industrial, commercial, institutional, and residential—particularly those constructed prior to the mid-1970s, when the EPA began limiting its use. Because of the widespread use of asbestos in building materials and friction products, it is commonly found in the environment.

Typical concentrations of airborne asbestos in urban settings have been reported to be approximately 0.0001 f/cm^3 and have been reported to range to 0.001 f/cm^3 PCME (ATSDR 1995). The size fraction reported is typically greater than 5 microns. Studies assessing asbestos concentrations associated with urban traffic and braking have reported concentrations in the range of 0.0002 – 0.0004 f/cm^3 (Jaffrey 1990).

At this Site, asbestos is long-lived in soil. Transport could occur by soil disturbance and transport by wind of fugitive dust. As stated previously, inhalation is the primary route of exposure for asbestos.

6.2 SVOCs

A variety of SVOCs are present, primarily in soil, at the Site. Most of the detected compounds are PAHs. These compounds are components of petroleum and can be found in combustion products. Ash has been observed in fill at the Site. In addition, low concentrations of phthalates, which are plasticizers, have also been detected. In general, these SVOCs are long-lived in the environment and common urban contaminants. They have limited solubility in water and tend to remain absorbed to soil. As such, exposure at the Site would most likely occur during soil disturbance via direct exposure to the soil through dermal contact or accidental ingestion or inhalation of fugitive dust. Transport mechanisms which would be necessary to complete these exposure pathways would be movement of soils and transport by wind of fugitive dust.

6.3 METALS

Heavy metals were detected in soil and ground water at Russell Field. At some locations where elevated concentrations of metals were observed in soil, ‘klinkers’ and ash were observed. These conditions are common in urban fill. Metallic compounds have a wide variety of solubilities and, therefore, depending upon oxidation/reduction conditions, metals can occur in a variety of states. At Russell Field, significant concentrations of

metals have only been detected in soils. Some metals are also present in low concentrations (below RCs) in ground water at the Site. As such, exposure at the Site would most likely occur during soil disturbance via direct exposure to the soil through dermal contact or accidental ingestion, or inhalation of fugitive dust. The exposure pathways could only occur through movement of soil or transport by wind of fugitive dust.

6.4 VOCs

Low concentrations of VOCs were detected in ground water (below GW-2 and GW-3 clean-up standards) and soil at the Russell Field Site (all below RCs with the exception of naphthalene in soil). Napthalene is also considered an SVOC and is a PAH. The remaining VOCs detected are primarily common solvents or their degradation products. VOCs tend to be more soluble in ground water than SVOCs, but are also present absorbed to soil. Their fate includes dissolution from soils into ground water, degradation through biological and chemical processes, and volatilization to soil gas or ambient air. Although observed concentrations were low, potential transport mechanisms evaluated in this assessment include volatilization from ground water into indoor air for the proposed field house, volatilization into construction trenches, direct exposure via dermal contact with soil and ground water, or accidental ingestion of soil.

7.0 PUBLIC HEALTH RISK CHARACTERIZATION

This section summarizes the results of a Method 3 Public Health Risk Characterization for the Russell Field Site. This assessment was conducted in accordance with the MCP. As such, the calculation of risk posed by asbestos and non-asbestos COCs are discussed in separate sections below due to differences in methodologies. Results of these characterizations are evaluated on a cumulative basis in the summary portion of this Section. Detailed tables with input data and calculations can be found in Appendices N and O.

7.1 HAZARD IDENTIFICATION—NON-ASBESTOS CONTAMINANTS OF CONCERN

Tables N.1 – N.6 in Appendix N provide detected concentrations, average concentrations, and EPCs for non-asbestos COCs at Russell Field. Maximum and minimum detected concentrations and UCLs are provided in Tables 5.6 and 5.7. COCs were selected based upon the following criteria; compounds were included as COCs if present at detectable concentrations in at least 5% of samples and present above published background concentrations.

For metals and PAHs, maximum concentrations were compared to the background concentrations provided in the MADEP Technical Update: Background Levels of Polycylic Aromatic Hydrocarbons and Metals in Soil. Comparison to urban background levels is appropriate due to the presence of ash in fill at the Site. Comparison (for metals) is summarized in Table 7.1. Based upon a comparison to background, the following inorganic compounds were eliminated from consideration as COCs in soil: antimony, beryllium, cadmium, chromium, mercury, and selenium. None of the maximum detected values of PAHs were below background levels. Di-n-butyl phthalate was eliminated from the COC list because it is present in less than 5% of the soil samples (see Table 5.6). All other detected compounds were evaluated as COCs.

Table 7.1 Maximum Inorganic Compounds Detected—Comparison to Urban Background Concentrations

Compound	Maximum Soil Concentration		MADEP RCS-1	Background Urban Fill (mg/kg)
	Location	(mg/kg)		
Antimony	Zone 10	**6.3**	10	7
Arsenic	C199-S1P	20	30	20
Beryllium	Garden	**0.84**	0.7	0.9
Cadmium	PS-4	**2.1**	30	3
Chromium	PS-6	**32**	1,000	40
Copper	PS-4	10,000	100	200
Lead	PS-6	1,300	300	600
Mercury	C82-S1P	**0.39**	20	1
Nickel	PS-4	310	300	30
Selenium	Garden	**0.85**	400	1
Silver	PS-4	6.7	100	5
Zinc	PS-4	580	2,500	300

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration, Soil Category 1
MCP Massachusetts Contingency Plan
mg/kg milligrams per kilogram
NS no standard
(J) estimated value, below quantification limit
(B) found in associated blank as well as sample
(D) surrogate diluted out

Boldface type indicates concentration below urban background.

7.2 EXPOSURE ASSESSMENT

The exposure assessment for Russell Field provides an evaluation of current and potential future exposure to Site-related contaminants. Currently, the Site is a municipal park in the City of Cambridge, Massachusetts. As such, this open space is protected by Article 97 of the Massachusetts Constitution (Public Land Protection) and is unlikely to be redeveloped for other uses in the foreseeable future. Additional assessment is underway to determine if residential development is otherwise restricted at Russell Field and to further evaluate risk posed by asbestos in subsurface soils (deeper than three feet). Results of this assessment will be provided in an addendum to this report and will be used to determine if an Activity and Use Limitation (AUL) is warranted to further restrict potential future residential use of the property.

An extensive renovation of the park is scheduled to begin in 2004. These renovations will include improvements to the existing playing fields, extensive plantings and utility

work, and construction of a field house. Therefore, exposure scenarios evaluated include use of the property as a park and the property as a construction site. The human receptors are the construction workers, local residents/users of the park, and potential future workers in the field house. Evaluation of exposure to the construction workers is interpreted to be the most conservative estimate of risk for any site worker at Russell Field. It is anticipated that Site remediation will be completed in conjunction with Site renovation and in accordance with the MCP and CAO. Table 7.2 summarizes the Site conceptual model for the Russell Field public health risk characterization.

Table 7.2 Russell Field Site Conceptual Model/Exposure Profiles

Receptor	Exposure Point	Media/Exposure Pathway
Resident child (present and future)	Outdoor—at park	Soil: dermal contact and incidental ingestion
Resident adult (present and future)	Outdoor—at park	Soil: dermal contact and incidental ingestion
Construction worker (future)	Outdoor—subsurface excavation on the Site	Soil: Dermal contact, incidental ingestion, and inhalation of fugitive dust. Air: Inhalation of volatilized OHM during trenching or excavation. Ground Water: Dermal contact during trenching or excavation.
Resident child (future)	Outdoor—at residence during construction	Air: Inhalation/ingestion of fugitive dust during construction
Resident adult (future)	Outdoor—at residence during construction	Air: Inhalation/ingestion of fugitive dust during construction
Resident child (future)	Indoor air—field house	Air: Inhalation indoor air contaminants from ground water
Field house worker (future)	Indoor air—field house	Air: Inhalation indoor air contaminants from ground water

OHM oil or hazardous material

Tables N.7 – N.9 in Appendix N provide the exposure parameters for the receptors and pathways listed in Table 7.2. References for each of the selected parameters are included in the table footnotes. For each of the receptors, biological exposure parameters (such as body weight, ingestion rate, etc.) were selected based upon published guidance. The 'young child' age 1 to 6 years was selected as a most sensitive residential receptor. The adult resident experiences the longest-term potential exposure.

Site-specific variables were selected based upon conservative assumptions. For the construction workers, it was assumed they would be exposed to Site contaminants for a total of six months over a one-year period in accordance with MADEP guidance. For residential receptors, exposure to construction-related dust was assumed to occur over the same one-year construction period. For child and adult residents as users of the field, it was assumed that the frequency of exposure would be four times per week, May through September. The assumed exposure periods for children and adults is 6 and 30 years, respectively.

Predictive models were used to evaluate inhalation exposures to VOCs in ground water. Specifically, indoor air exposure was modeled for the child/resident user and the full-time worker at the proposed field house (indoor air). A separate model was used to evaluate worker exposure to VOCs while working in an excavation or trench. In addition, exposure assumptions were modified somewhat to assess the soil hot spot identified at C-39.

Ground water at the Site and in its vicinity is not used for drinking water and the Site is not located in a drinking water resource area. Residences in the area are serviced by municipal water and sewer systems. Therefore, ground water at the Site is not classified as GW-1, drinking water standards are not applicable, and drinking water is not considered as an exposure route. Because a new field house is planned at the property, potential impacts to indoor air from ground water are considered in this assessment; therefore, ground water at the Site is classified as GW-2. In addition, dermal contact with ground water by construction workers is anticipated based upon the depth to ground water and, therefore, this exposure pathway is evaluated in this assessment. Ground water at the Site is also classified as GW-3 and does have the potential to discharge to surface water.

Readily accessible soils (0 – 3') in depth are considered in the evaluation of risk for all receptors and, in particular, are used to evaluate current risk. These soils are classified as S-1 soils due to accessibility and high intensity use. In addition, potentially accessible soils (3 – 15') are classified as S-2 soils at the Russell Field Site. Both S-1 and S-2 soils are considered in the evaluation of future risk, because potential mixing of these soils could occur during proposed construction. Soils present at depths greater than 15 feet

(S-3) are interpreted to be native materials and have a limited potential to be impacted by Site contamination.

7.2.1 Exposure Point Concentrations—Non-Asbestos Contaminants of Concern

For ground water, maximum values detected were selected as the EPCs for risk characterization due to limited ground water sampling. Ground water concentrations did not exceed RCs and, therefore, ground water was only tested during preliminary investigations.

For soils, average values (excluding the hotspot at C-39) were calculated to develop EPCs. This approach is justified because contamination at the Site is present sporadically in heterogeneous fill. Contaminant occurrence does not form a distinct pattern. It is also reasonably anticipated that users of the field will spend time in a variety of Site locations. These averages are based upon a large number of samples from all areas of the park. This risk assessment characterizes chronic and subchronic exposures. At the concentrations detected, severe health effects are not anticipated due to short-term exposure to Site COCs.

If a COC was not detected in a sample, a value of one-half the detection limit was included in the average calculation. Multiple calculations were completed to evaluate risk based upon soil depths and the identification of hot spots. To evaluate current use of the Site as a public park, EH&E evaluated risk posed by contaminants present in the upper three feet of soil. Soil from all depths was also evaluated because it is assumed that they could be brought to the surface during planned field renovations. Therefore, evaluation of the 0 – 3 foot depth range can be interpreted to represent current conditions and all depths are evaluated for potential future scenarios. EPC calculations are summarized in Tables N.1 – N.6 in Appendix N.

In addition, EPCs were modeled for two specific potential exposure scenarios. Construction workers building the proposed field house or working in other excavations could be exposed to VOCs in ground water due to the relatively shallow depth to the water table. Although dewatering is planned during construction, it is possible that standing water will accumulate in portions of the excavation area. Therefore, risks

associated with this route of exposure were assessed. The inhalation EPC was modeled in two steps. First, a compound-specific emission rate from the surface of the water was predicted and this was input into a simple box model to predict ambient concentration. The emission rate model is a conservative screening-level model (RTI Model, EPA, 1990) that predicts the mass transfer of VOCs from a liquid surface to the air. The mass emission rate is based on the compound's overall mass transfer coefficient, the area of the liquid surface, and the concentration of the contaminant in the ground water. The model is described in full in Appendix O.

Conservative assumptions were made in this model: 1) 50% of the area of excavation was assumed to be covered with water and 2) maximum ground water concentrations were used. These assumptions mean the predicted EPC is likely to be overestimated. Table O.1 shows all the inputs to the RTI model and the predicted ambient air concentration.

Indoor air concentrations were also modeled for field house users and workers. The construction of a new field house is proposed for this Site. Volatile contaminants in ground water will diffuse into the soil gas and, when beneath a building, this soil gas can infiltrate a building. Indoor air concentrations were modeled based on the approach of Johnson and Ettinger (1991) using software developed by EPA (2003). The Johnson and Ettinger (1991) model calculates an attenuation factor that is based on site-specific characteristics. This model assumes a mass balance whereby the mass transport rate of contaminants volatilizing from the ground water under the building is equal to the mass transport rate through cracks in the basement slab, which is also equal to the mass transport rate of air circulating through the building.

Conceptually, the attenuation factor is calculated in three steps: 1) contaminants diffuse from the ground water into the soil gas beneath the building; 2) contaminated soil gas is transported into the building; and 3) the mass flow through the cracks is diluted by the building air exchange rate. The attenuation factor is then multiplied by the contaminant concentration in ground water and the appropriate Henry's Law constant to predict the indoor air concentration. The EPA model also contains an algorithm for calculating risk, assuming the building is a residence. This algorithm was not used; a site-specific exposure algorithm was used based on the expected future use of the field house.

Numerous site-specific parameters are required for input to the model. The proposed field house is a two-story slab-on-grade building with an elevator. The elevator will extend further below ground surface than the building slab foundation. Due to the very different characteristics of the elevator shaft and the main building, the model was run separately, once for the field house building and then again for the elevator shaft. Model inputs for the field house slab foundation portion are shown, along with their rationale, in Table O.2 in Appendix O. Table O.3 shows the model inputs for the field house elevator shaft. The differences between the two sets of inputs are in the depth below grade to the floor of enclosed space and the length and width of the building. For the main building, the depth below grade for the enclosed space is 15 centimeters (cm) and for the elevator shaft, it is 91 cm. The length and width of the main building are approximately 37 m by 29 m, and for the elevator shaft are 1.75 m by 2.5 m.

All ground water data and depth information were taken from the three wells closest to the planned field house construction site, PS-8, PS-9, and PS-13. The maximum concentrations and minimum ground water depth were used for all model runs. The output of the EPA Vapor Intrusion Model is presented in Appendix O. For both structures modeled, there are tables for each compound. The first page of Table O.4 contains the data entry information and the second part the intermediate calculations. It is in this second part of the table that the predicted indoor air concentration is shown.

The EPC for indoor air was calculated as a weighted average. The duration of exposure for the resident/user in the field house was assumed to be 4 hours, the same amount of time as that for the playing fields. Of the 4 hours an individual spends in the field house, 0.25 hours are assumed to be in the elevator and 3.75 hours are in the field house. The worker was assumed to spend 8 hours a day, 5 days a week in the field house. Appendix O, Table O.4 presents the EPCs for the three VOCs (trichloroethylene, tetrachloroethylene, and naphthalene) in ground water, as well as the site-specific exposure parameters. It was very conservatively assumed that a resident child would use the field house every year, from the age of 1 through 18 years. The adult resident and Site worker were assumed were assumed to use the field house for 30 years and 15 years, respectively.

7.2.2 Hotspot Analysis

One hotspot in soil was identified at Russell Field and treated as a separate exposure point in accordance with the MCP. This location, C-39 had significantly elevated concentrations of PAHs over depths ranging from 0.5 to 8.5 feet in depth. This thickness of homogeneous black-stained fill is notable, and not typical of most locations evaluated at Russell Field. This is a discrete area and concentrations of PAHs at this location were at least one and often two orders of magnitude greater than at surrounding sampling locations. Concentrations of two PAHs, benzo(a)pyrene and benzo(a)anthracene, exceeded UCLs at this location. UCLs were not exceeded for any other contaminants, nor at any additional locations across the Site.

It should be noted that, under current Site conditions and typical use of the field, no complete pathway for exposure to these soils exists. They lie beneath six inches of soil and vegetation. Significant earthwork is proposed during renovations planned in 2004 and 2005. Removal of these soils is recommended at that time. The depth of impacted fill at C-39 ranges from approximately 0.5 to 8.5 feet.

7.3 TOXICITY ASSESSMENT

Toxicity values are listed in Tables N.10 – N.12 in Appendix N. These values were compiled from multiple sources, and the source for each value is indicated in the reference number for each value. Complete references are included in Section 10.0 of this report. References were searched in the following order; where applicable, lower order number references were given priority over higher numbered sources:

1 = EPA Integrated Risk Information System (IRIS)
2 = MADEP #2 Fuel/Diesel Risk Assessment ShortForm—Working Draft
3 = MADEP Gasoline Release ShortForm—Working Draft
4 = EPA Region 3 Risk-Based Concentration Table
5 = EPA Health Effects Assessment Summary Tables
6 = MADEP Polycyclic Aromatic Hydrocarbons (PAHs)
7 = MADEP Background Documentation for Development of the Massachusetts Contingency Plan Numerical Standards
8 = Chronic toxicity values used for subchronic

9 = MADEP Documentation for the Inhalation Cancer Unit Risk Value for Tetrachloroethylene
10 = EPA User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings

7.4 QUANTITATIVE ESTIMATION OF EXPOSURE

Tables N.13 – N.24 in Appendix N summarize the calculations completed to quantitatively estimate exposure to non-asbestos COCs at Russell Field. Using the calculated EPCs in Tables N.1 – N.6, the exposure factors listed in Tables N.7 – N.8, and where appropriate, the Relative Absorption Factors (RAFs) listed in Tables N.10 – N.12, Average Daily Doses (ADDs) or Average Daily Exposures (ADEs) were calculated for all predicted exposure scenarios for the potential receptors. Quantitative estimation of exposure was completed for COCs for identified pathways, unless toxicity data were not available to support calculation.

For current Site conditions, EPCs based upon concentrations detected in the top three feet of soil were evaluated. For future Site conditions during construction and eventual reuse of the field as a park, EPCs were calculated using data from all soil depths. Separate calculation tables are provided for exposure to shallow soils and all soils.

Quantitative estimation of exposure was conducted separately for the hotspot at C-39 (Tables N.25 – N.30). However, concentrations of two PAHs exceeded UCLs at this location; remediation of these soils must be implemented. Given proposed future use at this location as a baseball field, soils with this level of contamination cannot remain unremediated.

7.5 RISK CHARACTERIZATION

7.5.1 Non-cancer Risk

Table 7.3 summarizes the total current and future non-cancer risk or Hazard Index (HI) for each receptor via each potential exposure pathway at Russell Field. This matrix includes both current and future use of the Site. Tables in Appendix N provide the calculated exposure values and toxicity values (reference dose or concentration) used to calculate HI. Non-cancer risks from exposure to C-39 are not included in Table 7.3 but

can be found in Appendix N. As these soils will be removed, no long-term risk exists and calculated risks due to exposure to C-39 are purely hypothetical.

Table 7.3 Summary of Non-Carcinogenic Risk for Non-Asbestos COCs

Pathway	Resident Adult (HI)	Resident Child (HI)	Construction Worker (HI)	Field House Worker
Current Exposures (samples from 0 – 3 feet)				
Dermal Exposure—Soil	0.0094	0.077	NA	NA
Incidental Ingestion—Soil	0.021	0.18	NA	NA
Total	0.03	0.26	NA	NA
Future Exposures (samples from all depths)				
Dermal Exposure—Soil	0.0089	0.072	0.019	NA
Dermal Exposure—Ground Water	NA	NA	0.03	NA
Inhalation/Ingestion—Fugitive Dust	0.00023	0.00023	0.0017	NA
Inhalation—Indoor Air (Field House)	0.1	0.063	NA	0.54
Inhalation—Construction Trench	NA	NA	0.00049	NA
Incidental Ingestion—Soil	0.019	0.17	0.048	NA
Total	0.13	0.31	0.10	0.54

HI Hazard Index
NA not applicable

Results of these calculations indicate that none of the HIs calculated for site receptors exceed the MCP limit of 1.0.

7.5.2 Carcinogenic Risk

Table 7.4 summarizes the total carcinogenic risk or Excess Lifetime Cancer Risk (ELCR) for each receptor via each potential exposure pathway at Russell Field. This matrix includes both current and future use of the Site. Tables in Appendix N provide the calculated exposure values and toxicity values (slope factor or unit risk) used to calculate ELCR.

Table 7.4 Summary of Carcinogenic Risk for Non-Asbestos COCs

Pathway	Resident Adult (ELCR)	Resident Child (ELCR)	Construction Worker (ELCR)	Field House Worker
Current Exposures (samples from 0 – 3 feet)				
Dermal Exposure—Soil	1.0E-6	2.1E-6	NA	NA
Incidental Ingestion—Soil	2.0E-6	2.6E-6	NA	NA
Total	3.0E-6	4.7E-6	NA	NA
Future Exposures (samples from all depths)				
Dermal Exposure—Soil	1.0E-6	1.7E-6	8.2E-8	NA
Dermal Exposure—Ground Water	NA	NA	3.7E-6	NA
Inhalation/Ingestion—Fugitive Dust	1.4E-9	1.4E-9	1.0E-8	NA
Inhalation—Indoor Air (Field House)	1.2E-6	7.4E-7	NA	6.4E-6
Inhalation—Construction Trench	NA	NA	5.7E-8	NA
Incidental Ingestion—Soil	1.0E-6	2.3E-6	1.1E-7	NA
Total	3.2E-6	4.7E-6	4.0E-6	6.4E-6

ELCR Excess Lifetime Cancer Risk
NA not applicable

A condition of No Significant Risk due to non-asbestos contaminants can be achieved at Russell Field, assuming that soils at C-39 are mitigated. Additionally, comparison of results for soils above and below the three foot depth horizon do not indicate a significant difference in risk posed by either stratum. Risks from exposure to C-39 can be found in Appendix N. As these soils will be removed, no long-term risk exists and calculated risks are purely hypothetical.

7.6 EXPOSURE POINT CONCENTRATIONS FOR ASBESTOS

Characterization of risk due to exposure to asbestos in soil presents unique challenges because quantification of concentrations in soil by available methods yields unacceptably high detection limits and a high degree of variability in quantitative analytical results. In particular, the most widely accepted method of soil analysis for asbestos, the EPA Region 1 Protocol for Screening Soil and Sediment for Asbestos Content, has a detection limit of 1% and was not intended to provide quantitative results. Furthermore, most standard analyses via PLM or TEM use a very small fraction of the soil sample which may not be representative. Results of analysis in soil must then be used to estimate inhalation exposure for asbestos, adding additional uncertainty. These limitations make it difficult to develop a site-specific or Method 1 clean-up standard based upon soil concentrations.

EH&E employed a variety of PLM and TEM methods for soil and air at Russell Field. For risk characterization, EH&E relied on air monitoring results to assess use of the Site as a park (based upon current conditions). EH&E relied on the EPA Elutriator Method to develop asbestos source generation rates for Russell Field soils during construction or other soil disturbing activities. The Elutriator Method uses a much larger soil sample and provides a generation rate for asbestos from soil that can be used more directly in risk characterization. The methods employed are discussed in detail in this Section.

During the Phase I and Phase II Site Assessment programs, a total of 1,087 soil samples were collected and analyzed via PLM with selected samples reanalyzed via TEM (as described in previous report sections). These results can be summarized as follows: in 1,087 total samples, only 33 soil samples contained trace level concentrations (<1%) of asbestos and four soil samples contained greater than 1% asbestos. Therefore, asbestos was detected in soil in 3.4% of the samples. In addition, debris containing asbestos at concentrations greater than 1% were detected in three locations.

7.6.1 Air Monitoring

EH&E used multiple approaches to evaluate EPCs for asbestos. To evaluate current Site conditions, air monitoring was conducted. As described in Section 5.4.1, monitoring was conducted under 'dry' typical conditions, and during multiple rounds of Site assessment, which included drilling operations and sampling of surface soils. In all cases, concentrations of total fibers and/or asbestos at upwind and downwind locations were similar and within the range of reported urban background concentrations. These results are summarized in Tables G.5 – G.26, Appendix G.

7.6.2 Soil Analysis

To develop EPCs resulting from soil disturbance during current use scenarios and for potential future use of the Site, EH&E conducted two types of analysis. The first was employed prior to the development of draft MADEP guidance on analytical methods for asbestos in soil. Selected archive samples, primarily from locations where trace level concentrations were detected previously, were analyzed by TEM via a modified Environmental Laboratory Accreditation Program 198.1 Method with Chatfield preparation and 1,000 points counted. This method achieved a detection limit of 0.10%

asbestos. No asbestos was detected in these samples. Analytical data sheets are included in Appendix P. However, a significant limitation of this method is the small sample quantity used for actual analysis.

Based upon subsequent MADEP draft guidance, additional archived soil samples were composited into nine samples for analysis via the Draft Modified Elutriator Method for the Determination of Asbestos in Soils and Bulk Material (EPA-540-R97-028 EPA Superfund). Laboratory data sheets are included in Appendix P. All of these samples were collected from fill in the top three feet of soil. The compositing strategy is illustrated in Figure 9 in Appendix C and is based upon field use. Table P.1 in Appendix P details the composite fractions. Specifically, soils were composited based upon the locations of playing fields and other Site features where they will be located subsequent to field renovation in 2004/2005. The only significant change in feature location (which is reflected in the composites) is a shift in the orientation of Samp Field, the baseball diamond located at the center of the park.

EH&E evaluated the fraction of samples with detected concentrations of asbestos versus non-detect samples. For eight of the nine samples which represent the eight use zones, EH&E maintained a similar fraction of trace level detections with non-detect soil. Where archived samples were limited, additional trace level soils from the composite area were used in place of non-detect soil.

A ninth composite sample was created only from samples from the parking lot area which contained trace levels of asbestos. This sample was prepared in order to better evaluate the potential construction scenario where a worker might be directly exposed to a more concentrated area of trace level detections. The parking lot was chosen as the zone for evaluation because it has the highest frequency of trace level detections.

Soil from depths greater than three feet with trace level concentrations of asbestos have not yet been evaluated via the Elutriator Method. Due to the high cost associated with the use and interpretation of this method, it was desirable to first determine if an AUL is necessary for other COCs for soils in this stratum. Because no AUL is currently indicated, it is anticipated that these soils will be evaluated and this risk assessment will be updated.

Results of the Elutriator Method provide a laboratory-based generation rate for asbestos fibers from soil into air. Soil samples are placed in a tumbler and air samples are collected from the apparatus during tumbling. Asbestos fiber generation rates measured by this method are then applied to dust generation rates for typical construction sites to predict airborne concentrations of asbestos fibers.

Protocol Asbestos Fibers are counted using standard TEM analysis for the air samples collected from the tumbler. Based upon this analysis, no Protocol Fibers were detected for any of the nine Russell Field composite samples collected from the top three feet of soil. Because protocol fibers were not detected in any of these samples, the EPC defaults to a concentration of zero.

Although not required, an extremely conservative evaluation could use a value of ½ the detection limit to calculate a hypothetical EPC. As such, an EPC was calculated using the source generation rate of 5.7E7 structures per gram of particulate matter with an aerodynamic diameter of 10 microns or less (based upon Elutriator results) and the MADEP default value for dust generation at a construction site of 60 micrograms per cubic meter ($\mu g/m^3$). Structures were considered equivalent to fibers. Therefore, the EPC of 3.4E-3 was calculated using the following formula:

Average Elutriator Results × 60 $\mu g/m^3$ × Units Conversion Factor = EPC (structures per cubic centimeter [s/cm^3])

Soil samples with greater than 1% asbestos in soil were not evaluated via the Elutriator Method, because these soils will be removed prior to initiation of any earthmoving activities at the Russell Field Site. The four locations with greater than 1% detected asbestos in soil will be remediated using methods specified in the CAO. This remediation will also be conducted in accordance with the MCP. The CAO Remediation Plan for Russell Field will be submitted as a portion of the Phase IV Remedy Implementation Plan for this Site. These remediation locations were described in Section 5.3.1 of this report.

Additionally, asbestos-containing debris (asbestos concentrations greater than 1%) was identified at three locations at Russell Field. These locations will be abated in accordance with the MCP and other applicable regulations and standards. These locations were described in Section 5.3.1 of this report.

7.7 RISK ASSESSMENT FOR ASBESTOS

7.7.1 Toxicity Assessment

The EPA IRIS database lists an inhalation unit risk of 0.23 per fiber/milliliter. This unit risk is based upon fiber counts made by PCM. As such, it should not be applied directly to results by other methods. For this evaluation, EH&E considered asbestos fibers measured in PCM equivalents or as Protocol Fibers, depending upon the method of analysis.

No reference doses (RfDs) nor reference concentrations (RfCs) are available through IRIS for asbestos. EH&E did not identify toxicity values for non-cancer risk for asbestos exposure in any of the resources listed in the references listed in Section 7.3.1.

7.7.2 Quantitative Estimation of Exposure

Risks posed by exposure to asbestos are assessed for non-construction and construction periods. For the off-site resident during non-construction periods, analysis of current and future risk at the Site as a park is based upon air monitoring. As discussed in Sections 5.4 and 7.4, asbestos was not detected in air samples collected during several rounds of assessment activities at Russell Field, and was detected at concentrations consistent with urban background during more aggressive testing conducted during August 1999. Therefore, asbestos for this exposure scenario is not quantitatively evaluated in this Section.

Quantitative estimation of exposure was conducted for the construction scenario using the results of EPA Elutriator Method analysis. Protocol Fibers correspond to the size fraction evaluated using the EPA Unit Risk value. Because Protocol Fibers were not detected in any of these samples, the predicted ELCR from this exposure route is zero.

Although not required because Protocol Fibers were not detected in any of the samples, EH&E also calculated potential risk due to inhalation of asbestos during construction based upon the average value of one-half of the detection limits for the nine soil samples analyzed via the Elutriator Method. This provides a very conservative estimate of potential risk due to asbestos exposure during construction. Risk was generally calculated using the exposure assumptions and factors used for non-asbestos COCs, and the unit risk value provided in Section 7.7.1. More specifically, the construction worker was assumed to be exposed five days/week and eight hours/day for 50 weeks in one year. The residents were assumed to be exposed seven days/week and four hours/day for 50 weeks in one year.

Therefore, the ADE was calculated:

$$ADE = EPC \times \left(\frac{ET \times EF \times ED}{AP \times CF} \right)$$

where,
AP = averaging period
CF = units conversion factor
ED = exposure duration
EF = exposure frequency
ET = exposure time

7.7.3 Carcinogenic Risk

Based upon air monitoring results, risk due to exposure to asbestos in soil during use of the Site as a park would be zero. Measured concentrations were consistent with urban background and did not indicate any significant contribution to air from the Site. Because no Protocol fibers were detected in any of the samples analyzed via the EPA Elutriator Method, the calculated ELCR from potential exposure to asbestos at the Russell Field Site during soil disturbing construction activities is also zero for all receptors (PC Paul Locke, MADEP).

Using a very conservative approach, construction scenario risk was alternately calculated using an EPC of half the average detection limit. Table 7.5 summarizes the results of those calculations.

$$ELCR = ADE \times Unit\ Risk$$

Table 7.5 Estimated Carcinogenic Risk Due to Asbestos Exposure during Construction (future)

Receptor	EPC (s/cm^3)	ADE (s/cm^3)	Unit Risk (per f/cm^3)	ELCR
Construction Worker	3.4 E-3	1.1 E-5	0.23	2.57 E-6
Resident	3.4 E-3	7.7 E-6	0.23	1.79 E-6

EPC Exposure Point Concentration
ADE Average Daily Exposure
ELCR Excess Lifetime Cancer Risk
s/cm^3 structures per cubic centimeter
f/cm^3 fibers per cubic centimeter

7.8 RISK TO PUBLIC SAFETY AND WELFARE

Contaminants at Russell Field do not pose a Risk to Public Safety. Contaminants detected are not corrosive, flammable, reactive, infectious, nor do they pose a risk of explosion or fire. No open pits nor lagoons are present at the Site. No containers of hazardous materials are present.

Contaminants at the Site do not create odors nor other nuisance conditions. However, two compounds were detected at concentrations exceeding UCLs at C-39. This poses a potential Risk to Public Welfare. Therefore, remediation of soils at C-39 is recommended.

7.9 SUMMARY OF HUMAN HEALTH RISK

The total ELCR for receptors at the Russell Field Site is calculated by summing the ELCR values for non-asbestos COCs and asbestos. Asbestos exposure does not affect the HI for the Site because toxicity data for non-cancer health risk are not available for asbestos. Therefore, HIs presented in Table 7.3 provide estimated values for total non-cancer risk at the Site.

Both current and future cancer risk due to asbestos default to zero based upon air monitoring and Elutriator analysis, respectively. However, Table 7.6 provides a summary of potential future carcinogenic risk, which includes the very conservative values calculated using one-half the detection limit for Elutriator Method results. The total ELCRs are listed by receptor in Table 7.6.

Table 7.6 Total Carcinogenic Risk—Russell Field

Receptor	ELCR (Non-Asbestos COCs)	Potential ELCR Asbestos	Total ELCR
Current Exposures			
Resident Child	4.7E-6	0	4.7E-6
Resident Adult	3.0E-6	0	3.0E-6
Future Risk			
Resident Child	4.7E-6	1.8E-6	6.5E-6
Resident Adult	3.2E-6	1.8E-6	5.0E-6
Construction Worker	4.0E-6	2.6E-6	6.6E-6
Field House Worker	6.4E-6	0	6.4E-6

ELCR Excess Lifetime Cancer Risk
COC Contaminant of Concern

Results of risk characterization for human receptors at Russell Field indicate the following:

- Locations with asbestos concentrations greater than 1% in soil will be remediated in accordance with the CAO, the MCP, and other applicable regulations, and therefore, are not further characterized here.

- Locations with asbestos concentrations greater than 1% in debris will be remediated in accordance with the MCP and other applicable regulations and, therefore, are not further characterized here.

- A hotspot was identified at C-39; benzo(a)anthracene and benzo(a)pyrene are present at concentrations exceeding UCLs at this location. Risk calculations also indicate potential significant risk due to human receptors at this exposure point.

- No significant risk is indicated for human receptors in the absence of the C-39 exposure point and pending limited additional assessment of asbestos in soil.

- Exceedance of UCLs at C-39 indicates a potential Risk to Public Welfare.

- No Risk to Public Safety as a result of Site contamination is indicated.

If exposure to contamination at C39 is mitigated to provide a condition of No Significant Risk, results of this assessment do not indicate the need for an AUL at this Site to protect against exposure to non-asbestos COCs in soils deeper than 3 feet. Limited additional evaluation of archived soils from locations greater than three feet in depth is recommended to characterize potential risk from exposure to trace level concentrations of asbestos in this stratum. Upon completion of analysis via the EPA Elutriator Method, those results should be evaluated in conjunction with the results of this assessment to determine if an AUL is required for soil at depths greater than three feet.

7.10 UNCERTAINTY ANALYSIS

The following paragraphs provide an evaluation of uncertainty in this risk characterization.

7.10.1 Ground Water

Limited ground water sampling was conducted at the Russell Field Site and, therefore, the EPC for ground water may be lower or higher than actual conditions. However, additional ground water sampling was not conducted because only a limited number of compounds were detected in ground water, no known or suspected source of ground water contamination was identified for the Site, and all detected concentrations were below RCs. Further, the COCs detected in soils at the Site are generally not highly soluble. Maximum ground water concentrations detected were used in risk characterization.

7.10.2 Soil

Significant uncertainty lies in the reliability of asbestos analysis of soil. This uncertainty is principally a result of the limitations of analytical methods. However, EH&E collected a very large number of samples for analysis via a variety of analytical methods. The detection frequency of asbestos in soil from Russell Field was low (3.4%). EH&E utilized draft MADEP guidance (all that is currently available) in the selection of both analytical methods and risk characterization strategy.

In general, characterization of soil at Russell Field is complicated by the lack of clear source areas. The urban fill present at Russell Field is heterogeneous in nature. However, it is assumed that the large number of samples that were collected from all areas of the Site provide a representative assessment of the Site as a whole.

7.10.3 Air

Multiple rounds of measured concentrations of asbestos in air were used to evaluate current Site conditions. All other airborne exposure routes were evaluated using calculated/modeled exposures. EH&E employed methods described in MADEP guidance (2002) to characterize risks posed by inhalation and ingestion of fugitive dust. Conservative assumptions were applied where EPCs were modeled, as detailed in Section 7.2.1.

7.10.4 Exposure Assumptions

It is important to note that, under current and future conditions, and with typical use of the field (not construction), a complete exposure pathway does not exist for exposure to fill at the Site. Fill is and will be overlain by topsoil in both scenarios. COCs in topsoil were generally below RCs.

EH&E used published values and guidance provided by MADEP and EPA to develop exposure assumptions for Russell Field and conservative assumptions for exposure scenarios. Assessment focused on the most sensitive receptors. While it is possible that, for any individual, exposure could be higher than those evaluated in this assessment,

assumptions employed are designed to be conservative representations of typical Site use.

Conservative exposure assumptions were used for the construction worker. The duration of exposure was assumed to be six months out of a one-year construction period and, during that time, the worker was assumed to be exposed to contaminants in Site soils the entire time.

For exposure to ground water, the construction worker was assumed to be exposed for 30 days. Exposure to ground water could occur during construction of the field house and during excavation of deeper trenches around the Site. As the field house will be a slab-on-grade structure, the excavation will not be open for 30 days. It is more likely to be open for 10 days; the remaining 20 days were conservative estimates for trenching activity. It was conservatively assumed that the same workers would be exposed to both field house and the trench excavations. However, these two types of work may be done by different contractors. Additionally, excavations and trenches will be dewatered, minimizing potential exposures.

8.0 ENVIRONMENTAL RISK CHARACTERIZATION

The purpose of this section is to provide an evaluation of potential risk to environmental receptors at Russell Field. In accordance with MADEP guidance, this evaluation will be revisited and updated as necessary subsequent to Site remediation.

8.1 POTENTIAL RECEPTORS

As stated in previous report Sections, no ACECs nor Habitats of Rare or Endangered Wildlife are present in the vicinity of Russell Field (see Figure 4). At Russell Field, the full acreage of the Site is developed as a municipal park. Therefore, in accordance with MADEP Stage I Screening guidance, no additional screening is necessary to evaluate terrestrial organisms and habitats. No surface waters nor wetlands are present at the Russell Field Site. Evaluation of potential aquatic and wetland receptors and exposure pathways in the vicinity of Russell Field are discussed in the following sections.

8.2 POTENTIAL EXPOSURE PATHWAYS

Ground water at the Site does have the potential to discharge to surface water bodies in the Site vicinity. However, concentrations of COCs in ground water are generally low to non-detect and do not exceed GW-3 standards. Concentrations potentially discharging to off-site surface water bodies would also be anticipated to be non-detect or below GW-3 Standards.

Local waterways and wetlands, such as Jerry's Pit and Alewife Brook, are not part of the Site but are subject to significant local conditions, including roadway run-off, storm-water discharge, and the fact that Jerry's Pit is located on a listed hazardous waste site.

Jerry's Pit is the surface water body that lies closest to the Russell Field Site. Erosion of soil from Russell Field into Jerry's Pit is limited by the fact that the portion of Russell Field that lies closest to Jerry's Pit is paved. This parking area along Rindge Avenue will remain a parking area subsequent to planned field renovations. Renovations at Russell Field will be conducted in accordance with all requirements of the Cambridge Conservation Commission, and precautions will be implemented to mitigate potential sedimentation to Jerry's Pit and Site storm-water systems.

Additionally, Jerry's Pit is encompassed by and is a part of the Grace Site (RTN 3-0000277). Haley and Aldrich, consultants to Grace, have conducted sediment and surface water testing at Jerry's Pit. Environmental Risk Characterization for the Grace Site is pending.

Most of Russell Field is covered by approximately one foot of topsoil or pavement. The entire Site is landscaped and much of it is irrigated. As discussed in previous report sections, concentrations of COCs do not exceed RCs in the topsoil. Therefore, direct exposure of environmental receptors to COCs in impacted fill and potential runoff at the Site is minimized. Further, artificial turf is proposed for the renovated football field, located at the north end of the Site (Figure 8).

The source of contamination at Russell Field is generally interpreted to be urban fill, which contains ash and other combustion waste. As such, many of the metals and PAHs identified at the Site were detected at concentrations below urban background levels, except at the C-39 hotspot where PAHs are elevated, PS-4 where elevated concentrations of metals were detected, and a limited number of additional locations (see Figures 7 and 8).

Concentrations of PAHs exceeding urban background concentrations occurred at depths greater than one foot in vegetated areas of the Site or beneath pavement, except at C-39, where a source area was encountered at a depth of 0.5 feet. C-39 is not located proximal to Jerry's Pit nor Alewife Brook and is vegetated.

A review of concentrations of metals detected in soils at Russell Field indicates that only five (copper, nickel, silver, zinc, and lead) are present at concentrations exceeding urban background levels provided in MADEP guidance. The highest detected concentration of arsenic is equal to the urban background concentration of 20 milligrams per kilogram (mg/kg). Of these metals, only nickel and lead are present above Method 1 Clean-up Standards. The exceedances of the Method 1 Clean-up standards occur at depths of 1.5 feet or greater. Further, it can be noted that concentrations of copper, nickel, and silver were only detected at concentrations that exceed urban background at PS-4. The sample from PS-4 was collected from depths of 1.5 – 4.0 feet. Additionally, PS-4 is

located near the Clifton Street entrance to the park and is not proximal to Jerry's Pit nor Alewife Brook. Lead exceeded urban background concentrations and Method 1 Clean-up standards at PS-6 collected from 2.3 – 2.8 feet in depth.

Therefore, under current Site conditions, a direct pathway cannot be readily demonstrated for transport of soil containing COCs in excess of urban background concentrations to waterways or wetlands in the vicinity of Russell Field. Implementation of appropriate and effective sediment control strategies during proposed or future construction events at the Site in accordance with applicable regulations and standards can mitigate impacts to nearby off-site waterways and wetlands.

As discussed in Section 7.0, UCLs for two PAHs were exceeded at the C-39 hotspot. It is recommended that this location be evaluated as part of Phase III activities, and in particular, removal and off-site disposal is anticipated for at least the top three feet of soil. It should be noted that this hotspot is not contiguous to Jerry's Pit.

8.3 CONCLUSIONS

As discussed in Section 7.0, UCLs for two PAHs were exceeded at the C-39 hotspot. It is recommended that this location be evaluated as part of Phase III activities and, in particular, removal and off-site disposal is anticipated for at least the top three feet of soil. Removal of this source area will mitigate potential risk from this exposure point to environmental and human receptors.

No surface water bodies nor wetlands are present on the Site. Local waterways and wetlands, such as Jerry's Pit and Alewife Brook, are subject to significant local conditions, including roadway run-off, storm-water discharge, and the fact that Jerry's Pit is located on a listed hazardous waste site. No detailed evaluation of terrestrial habitat is required because no ACECs nor Habitats of Rare or Endangered Wildlife are present in the Site vicinity and the Site is fully developed.

Results of this Stage I screening assessment indicate that, under current Site conditions, a direct pathway cannot be readily demonstrated for transport of soil containing COCs in excess of urban background concentrations to waterways or wetlands in the vicinity of

Russell Field. Implementation of appropriate and effective sediment control strategies during proposed or future construction events at the Site in accordance with applicable regulations and standards can mitigate impacts to nearby off-site waterways and wetlands. Concentrations of COCs in ground water, which could discharge to surface water in the Site vicinity, do not exceed GW-3 standards.

Therefore, except at C-39 where soil concentrations exceed UCLs, under current Site conditions, Risk of Harm to the Environment is not apparent. Potential risk exists during soil disturbing activities. This pathway can be controlled through the implementation of appropriate and effective sediment control strategies.

Results of this Stage I Environmental Screening (assuming remediation at C-39) indicate a condition of No Significant Risk of Harm to the Environment and, therefore, no Stage II Environmental Risk Characterization is required.

9.0 CONCLUSIONS

Russell Field is a municipal recreational facility located off Rindge Avenue in Cambridge, Massachusetts. The MADEP Release Tracking Number for the Site is 3-0017087. Phase I Site Assessment and Tier Classification was completed in 1999 and the Site is classified as Tier II. The conclusions of this Phase II Comprehensive Site Assessment are based upon data obtained during numerous field investigations conducted from 1998 to 2003.

COCs at Russell Field are found only in soil at concentrations exceeding MADEP RCs. Contaminants exceeding RCs include PAHs, and metals. Asbestos is also present in soil and debris. These contaminants are found in fill at various locations and depths across the Site. Therefore, the source of contamination is interpreted to be poor quality fill. Contaminant concentrations in ground water do not exceed GW-2 nor GW-3 clean-up standards. Air monitoring at Russell Field did not detect asbestos at concentrations above published background levels.

Results of risk characterization indicate the following:

- Locations with asbestos concentrations greater than 1% in soil will be remediated in accordance with the CAO and other applicable regulations, and therefore, are not further characterized here.

- Locations with asbestos concentrations greater than 1% in debris will be remediated in accordance with the MCP and other applicable regulations and, therefore, are not further characterized here.

- A hotspot was identified at C-39; benzo(a)anthracene and benzo(a)pyrene are present at concentrations exceeding UCLs at this location. Risk calculations also indicate potential significant risk due to human receptors at this exposure point. Remediation of this location is indicated.

- No Significant Risk is indicated for human receptors in the absence of the C-39 exposure point, and pending limited additional assessment of asbestos in soil.

- Exceedance of UCLs at C-39 indicates a potential Risk to Public Welfare.

- No Risk to Public Safety as a result of Site contamination is indicated.

- With the exception of the potential risk due to the UCL exceedances at C39, no risk of harm to environmental receptors is indicated.

Based upon these results, it is recommended that C-39 be evaluated as part of Phase III activities. In particular, removal and off-site disposal is anticipated for at least the top three feet of soil at identified remediation locations. Evaluation of remedial alternatives will be completed and a Phase III Remedial Alternatives Evaluation and Action Plan Report will be provided to the MADEP in accordance with the MCP.

If exposure to contamination at C39 is mitigated to provide a condition of No Significant Risk, results of this assessment do not indicate the need for an AUL at this Site for non-asbestos COCs in soil deeper than three feet. Limited additional evaluation of archived soils from locations greater than three feet in depth is recommended to characterize potential risk from exposure to trace level concentrations of asbestos in this stratum. Upon completion of analysis via the EPA Elutriator Method, those results should be evaluated in conjunction with the results of this assessment to determine if an AUL is required for soils at depths greater than three feet.

10.0 REFERENCES

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APPENDIX A

LIMITATIONS

LIMITATIONS

1. Environmental Health & Engineering, Inc.'s (EH&E) environmental site assessment described in the attached report, Project # 10515, *Phase II Comprehensive Site Assessment Report, RTN: 3-0017182* (hereafter "the Report"), was performed in accordance with generally accepted practices employed by other consultants undertaking similar studies at the same time and in the same geographical area; and EH&E observed that degree of care and skill generally exercised by such other consultants under similar circumstances and conditions. The observations described in the Report were made under the conditions stated therein. The conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of described services, nor beyond the time and budgetary constraints imposed by the client.

2. Observations were made of the site as indicated within the Report. Where access to portions of the site was unavailable or limited, EH&E renders no opinion as to the presence of chemical residues, or to the presence of indirect evidence relating to chemical residues in that portion of the site.

3. The observations and recommendations contained in the Report are based on limited environmental sampling and visual observation, and were arrived at in accordance with generally accepted standards of environmental assessment practice. The sampling and observations conducted at the site were limited in scope and therefore cannot be considered representative of areas not sampled or observed.

4. Where sample analyses were conducted by an outside laboratory, EH&E has relied upon the data provided and has not conducted an independent evaluation of the reliability of these data.

5. The purpose of the Report was to assess the characteristics of the subject site as stated within the Report. No specific attempt was made to verify compliance by any party with all federal, state, or local laws and regulations.

APPENDIX B

BWSC FORMS

APPENDIX C

FIGURES

APPENDIX D

DATA TABLES—ASBESTOS IN SOIL OR DEBRIS

DATA TABLES—ASBESTOS IN SOIL OR DEBRIS

Table D.1 Asbestos Detected in Soil Samples by PLM at Russell Field, Cambridge, Massachusetts, July 2002

Sample ID	Date Sampled	Asbestos Detected During Initial Analysis (7/9 – 7/22/02)	Asbestos Detected During Re-Analysis (8/7/02)	Sample Depth/Location
B-185 S1	7/16/02	CHR TR	0	2 – 36”/Parking lot
A-115 S1	7/15/02	AMO TR	0	2 – 11”/Parking lot
B-202 S1	7/15/02	CHR TR	0	2 – 36”/Parking lot
B-205 S1	7/15/02	CHR TR	0	2 – 36”/Parking lot
B-207 S1	7/15/02	CHR TR	0	2 – 18”/Parking lot
B-300 S2	7/16/02	CHR TR	0	8 – 36”/Baseball field dugout—stone dust
A-60 S1	7/15/02	CHR TR AMO TR	0	2 – 12”/Parking Lot
B-2 S3	7/8/02	CHR TR	0	15 – 36”/Grassy area
B-14 S2	7/8/02	CHR TR	0	12 – 36”/Grassy area
B-18 S2	7/8/02	CHR TR	CHR TR	6 – 36”/Soccer field—grass
B-27 S2	7/8/02	CHR TR	0	7 – 36”/Soccer field—grass
B-32 S3	7/8/02	CHR TR	0	18 – 36”/Soccer field—grass
B-71 S2	7/11/02	CHR TR	0	2 – 36”/Soccer Field—grass
B-166 S2	7/12/02	CHR TR	CHR TR	3 – 36”/Grass area adjacent to parking lot

TR <1% asbestos content
CHR chrysotile
AMO amosite

Samples analyzed by ProScience Analytical Services, Woburn, Massachusetts.
Analytical data from report for lab batch ID S15722.

Table D.2 Asbestos Detected in Soil Samples by TEM at Russell Field, Cambridge, Massachusetts, July 2002

Sample ID	Date Sampled	Type	% Asbestos	Sample Depth/Location
B-185 S1	7/16/02	Chrysotile	TR	2 – 36”/Parking lot
A-115 S1	7/15/02	Chrysotile	TR	2 – 11”/Parking lot
B-202 S1	7/15/02	Chrysotile	TR	2 – 36”/Parking lot
B-205 S1	7/15/02	Chrysotile	TR	2 – 36”/Parking lot
B-207 S1	7/15/02	Chrysotile	TR	2 – 18”/Parking lot
A-60 S1	7/15/02	Chrysotile	TR	2 – 12”/Parking lot
B-18 S2	7/8/02	Chrysotile	TR	6 – 36”/Soccer field—grass
B-27 S2	7/8/02	Chrysotile	TR	7 – 36”/Soccer field—grass
B-71 S2	7/11/02	Chrysotile	TR	2 – 36”/Soccer field—grass
B-166 S2	7/12/02	Chrysotile	TR	3 – 36”/grass area adjacent to parking lot
A-25 S2	7/16/02	Chrysotile	TR	12 – 18”/Fenceline—grass
B-40 S2	7/08/02	Chrysotile	TR	6 – 18”/Football field—grass
B-162 S1	7/11/02	Chrysotile	TR	0 – 4”/West of DCR pool—grass

TR trace (<1% asbestos content)

Samples analyzed by ProScience Analytical Services, Woburn, Massachusetts.
Results from batch report MT-02-23.

Table D.3 Results of Soil Samples Analyzed for Asbestos in Soil Samples by PLM at Russell Field, Cambridge, Massachusetts, May and June 2003

Sample ID	Date Sampled	Asbestos Type Detected During Initial Analysis (5/27 – 6/5/03)	% Asbestos	Sample Depth (in)/ Location/Sample Description
56812	5/29/03	ND	ND	16”/ESB3/Tan sand
56814	5/29/03	ND	ND	14”/ESB2/Black soil
B11S2	6/4/03	ND	ND	12”/ESB11/Soil surrounding 56773
B11BS2	6/4/03	ND	ND	12”/ESB11/Soil surrounding 56774
56801	6/5/03	ND	ND	36”/ESB10/Soil surrounding 56804
56803	6/5/03	CHR	TR	36”/ESB10/Soil surrounding 56804
56806	6/5/03	ND	ND	9”/ESB11/Soil surrounding 56808
56809	6/5/03	ND	ND	8”/ESB10/Soil surrounding 56810

in inches
ND not detected
CHR chrysotile
TR trace (<1% asbestos content)

Samples analyzed by ProScience Analytical Services of Woburn, Massachusetts using Method EPA/600/R-93/116. Sample preparation via EPA Region 1 River Sediments Screening Method.

Table D.4 Asbestos Detected in Soil Samples by PLM at Russell Field, Cambridge, Massachusetts, November and December 2003

Sample ID	Date Sampled	Asbestos type Detected During Initial Analysis (11/18 – 12/02/03)	% Asbestos	Sample Depth/Location
C11-S2	11/19/03	Chrysotile	TR	3.0' – 6.0'/parking lot
C38-S2	11/19/03	Chrysotile	TR	4.0'/grass in baseball field
C74-S1	11/24/03	Chrysotile	TR	3.0' – 5.0'/grass
C99-S1	11/24/03	Chrysotile	TR	3.0' – 7.0'/grass
C147-S1	11/24/03	Chrysotile	TR	3.0' – 4.5'/grass in football field
C150-S1	11/24/03	Chrysotile	2	3.0' – 4.5'/grass in football field
C176-S1 Dup	12/01/03	Chrysotile	TR	3.0' – 5.0'/grass along path

TR trace (<1% asbestos content)
CHR chrysotile

Samples analyzed by ProScience Analytical Services of Woburn, Massachusetts using Method EPA/600/R-93/116. Sample preparation via EPA Region 1 River Sediments Screening Method.

Table D.5 Asbestos Detected in Debris Samples by PLM at Russell Field, Cambridge, Massachusetts, May 2002 – December 2003

Sample ID	Date Sampled	% Asbestos Detected	Sample Depth/Location
A-25 S3	7/16/02	45 CHR	12-18"/Fenceline—grass
A-11 S3	7/10/02	CHR TR	3-12"/ Soccer Field—grass
C37-S1	11/19/03	CHR TR	4.5'/Baseball diamond
56813	5/29/03	ND	16"/ESB3
56816	5/29/03	CHR 20	14"ESB2
56773	6/4/03	CHR 35	12"/ESB11
56774	6/4/03	ND	12"ESB11
56804	6/5/03	ND	36"/ESB10
56808	6/5/03	CHR TR	8"/ESB11
56810	6/5/03	ND	9"/ESB10

CHR chrysotile
TR trace (<1% asbestos content)
ND not detected

Samples analyzed by ProScience Analytical Services, Woburn, Massachusetts by Polarized Light Microscopy NIOSH 7400.

APPENDIX E

DATA TABLES—ORGANICS ANALYSES

DATA TABLES—ORGANICS ANALYSES

Table E.1 Results of Analysis for Extractable Petroleum Hydrocarbons in Soil Samples Collected at Russell Field, Cambridge, Massachusetts on July 9, 2002

Compound	Sample Location B-51 S3 (depth=24")	MADEP RCS-1
	Concentration (mg/kg)	
Extractable Petroleum Hydrocarbon Ranges		
n-C_9 to n-C_{18} Aliphatic Hydrocarbons	BRL	1,000
n-C_{19} to n-C_{36} Aliphatic Hydrocarbons	**3,000**	1,000
n-C_{11} to n-C_{22} Aromatic Hydrocarbons	**4,100**	200
Unadjusted n-C_{11} to n-C_{22} Aromatic Hydrocarbons	**4,100**	200
Target Analytes		
Naphthalene	BRL	4
2-Methylnaphthalene	BRL	4
Phenanthrene	BRL	100
Acenaphthene	BRL	20
Acenaphthylene	BRL	100
Fluorene	BRL	400
Anthracene	BRL	1,000
Fluoranthene	BRL	1,000
Pyrene	BRL	700
Benzo(a)anthracene	BRL	0.7
Chrysene	BRL	7
Benzo(b)fluoranthene	BRL	0.7
Benzo(k)fluoranthene	BRL	7
Benzo(a)pyrene	BRL	0.7
Indeno(1,2,3-c,d)pyrene	BRL	0.7
Dibenzo(a,h)anthracene	BRL	0.7
Benzo(g,h,I)perylene	BRL	1,000

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
mg/kg milligrams per kilogram
BRL below laboratory reporting limit

Boldface type indicates concentrations above MADEP RCS-1.

Method: Method of the Determination of Extractable Petroleum Hydrocarbons, MADEP (1998). Method modified by use of microwave accelerated solvent extraction technique.
Samples analyzed by Groundwater Analytical, Inc, Buzzards Bay, MA.

Table E.2 Results of Subsurface Soil Analysis for Volatile Petroleum Hydrocarbons, Russell Field, November 18 – December 2, 2003

Compound	Sample Location			MADEP RCS-1
	C95-S3P (4' – 4.5')	C96-S4P (6.0')	C123-S1P (3.5' – 4.5')	
	Concentration (mg/kg)			
VPH Ranges				
n-C_5 to n-C_8 Aliphatic Hydrocarbons	BRL	BRL	BRL	100
n-C_9 to n-C_{12} Aliphatic Hydrocarbons	BRL	BRL	BRL	100
n-C_9 to n-C_{10} Aromatic Hydrocarbons	BRL	BRL	BRL	1,000
Unadjusted n-C_9 to n-C_{10} Aromatic Hydrocarbons	BRL	BRL	BRL	100
Unadjusted n-C_9 to n-C_{12} Aliphatic Hydrocarbons	BRL	BRL	BRL	1,000
Target Analytes				
Methyl *tert*-butyl Ether	BRL	BRL	BRL	0.3
Benzene	BRL	BRL	BRL	10
Toluene	BRL	BRL	BRL	90
Ethylbenzene	BRL	BRL	BRL	80
meta-Xylene and *para*-Xylene	BRL	BRL	BRL	500
ortho-Xylene	BRL	BRL	BRL	500
Naphthalene	2.9	BRL	BRL	4

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
mg/kg milligrams per kilogram
BRL below laboratory reporting limit

Boldface type indicates exceedance of MADEP RCS-1.

Samples analyzed by Groundwater Analytical of Buzzards Bay, MA using Method for the Determination of Volatile Petroleum Hydrocarbons, MADEP (1998).

Table E.3 Results of Analysis for Extractable Petroleum Hydrocarbons in Soil Samples Collected at Russell Field, Cambridge, Massachusetts on November 18 – December 2, 2003

Compound	Sample Location			MADEP RCS-1
	C123-S1P (3.5' – 4.5')	C96-S4P (6.0')	C95-S3P (4' – 4.5')	
	Concentration (mg/kg)			
Extractable Petroleum Hydrocarbon Ranges				
n-C_9 to n-C_{18} Aliphatic Hydrocarbons	33	BRL	BRL	1,000
n-C_{19} to n-C_{36} Aliphatic Hydrocarbons	**1,700**	BRL	270	1,000
n-C_{11} to n-C_{22} Aromatic Hydrocarbons	**460**	BRL	**240**	200
Unadjusted n-C_{11} to n-C_{22} Aromatic Hydrocarbons	**480**	BRL	**240**	200
Target Analytes				
Naphthalene	BRL	BRL	0.91	4
2-Methylnaphthalene	BRL	BRL	BRL	4
Phenanthrene	0.94	BRL	BRL	100
Acenaphthene	BRL	BRL	BRL	20
Acenaphthylene	BRL	BRL	BRL	100
Fluorene	BRL	BRL	BRL	400
Anthracene	BRL	BRL	BRL	1,000
Fluoranthene	1.7	BRL	BRL	1,000
Pyrene	1.7	BRL	BRL	700
Benzo(a)anthracene	0.70	BRL	BRL	0.7
Chrysene	0.73	BRL	BRL	7
Benzo(b)fluoranthene	0.90	BRL	BRL	0.7
Benzo(k)fluoranthene	0.53	BRL	BRL	7
Benzo(a)pyrene	1.0	BRL	BRL	0.7
Indeno(1,2,3-c,d)pyrene	0.73	BRL	BRL	0.7
Dibenzo(a,h)anthracene	BRL	BRL	BRL	0.7
Benzo(g,h,I)perylene	0.87	BRL	BRL	1,000

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
mg/kg milligrams per kilogram
BRL below laboratory reporting limit

Boldface type indicates concentrations above MADEP RCS-1.

Method: Method of the Determination of Extractable Petroleum Hydrocarbons, MADEP (1998). Method modified by use of microwave accelerated solvent extraction technique.
Samples analyzed by Groundwater Analytical, Inc, Buzzards Bay, MA.

Table E.4 Results of Subsurface Soil Analysis for Polycyclic Aromatic Hydrocarbons, Russell Field, November 18 – 21, 2003

Analyte	Sample Location									MADEP RCS-1
	C2-S1P (0.5' – 4.5')	C2-S2P (4.5' – 7')	C15-S1P (0.5' – 2')	C15-S2P (2' – 4.5')	C15-S3P (4.5' – 8.5')	C9-S1P (0.5' – 5.5')	C39-S1P (0.5' – 8.5')	C21-S1P (0.5' – 6')	C54-S1P (1' – 5.5')	
	Concentration (μg/kg)									
Naphthalene	BRL	BRL	BRL	BRL	BRL	BRL	**12,000**	BRL	BRL	4,000
Acenapthylene	520	BRL	BRL	BRL	BRL	BRL	4,200	BRL	BRL	100,000
Acenaphthene	430	BRL	BRL	BRL	BRL	BRL	**76,000**	BRL	BRL	20,000
Fluorene	410	BRL	BRL	BRL	BRL	BRL	64,000	BRL	BRL	400,000
Phenanthrene	6,100	BRL	BRL	BRL	BRL	1,100	470,000	630	BRL	100,000
Anthracene	1,900	BRL	BRL	BRL	BRL	BRL	97,000	BRL	BRL	1,000,000
Fluoranthene	12,000	600	BRL	BRL	BRL	1,300	330,000	1,000	BRL	1,000,000
Pyrene	10,000	520	BRL	BRL	BRL	1,000	450,000	860	BRL	700,000
Benzo(a)anthracene	7,100	370	BRL	BRL	BRL	580	**170,000**	470	BRL	700
Chrysene	**7,300**	390	BRL	BRL	BRL	720	**180,000**	530	BRL	7,000
Benzo(b)fluoranthene	**7,600**	410	BRL	BRL	BRL	600	**95,000**	430	BRL	700
Benzo(k)fluoranthene	6,600	340	BRL	BRL	BRL	530	**110,000**	430	BRL	7,000
Benzo(a)pyrene	**7,800**	410	BRL	BRL	BRL	600	**150,000**	520	BRL	700
Indeno(1,2,3-cd)pyrene	**1,900**	BRL	BRL	BRL	BRL	BRL	**68,000**	BRL	BRL	700
Dibenzo(a,h)anthracene	**850**	BRL	BRL	BRL	BRL	BRL	**28,000**	BRL	BRL	700
Benzo(g,h,i)perylene	1,800	BRL	BRL	BRL	BRL	BRL	77,000	500	BRL	1,000,000
2-Methylnaphthalene	BRL	BRL	BRL	BRL	BRL	BRL	**14,000**	BRL	BRL	4,000

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
μg/kg micrograms per kilogram
BRL below laboratory reporting limit

Boldface type indicates exceedance of MADEP RCS-1.

Samples analyzed by Groundwater Analytical of Buzzards Bay, MA using EPA Method 8270C.

Table E.5 Results of Subsurface Soil Analysis for Polycyclic Aromatic Hydrocarbons, Russell Field, November 24 and 25, 2003

Analyte	Sample Location							MADEP RCS-1
	C93-S1P (0.5' – 6')	C102-S1P (0.5' – 7.5')	C102-S1P Dup (0.5' – 7.5')	C162-S1P (0' – 8')	C110-S1P (0.5' – 4.5')	C110-S3P (4.5' – 7.5')	C135-S1P (0.5' – 4')	
	Concentration (µg/kg)							
Naphthalene	BRL	BRL	BRL	1,800	BRL	BRL	BRL	4,000
Acenapthylene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	100,000
Acenaphthene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	20,000
Fluorene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	400,000
Phenanthrene	BRL	BRL	BRL	600	380	BRL	BRL	100,000
Anthracene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	1,000,000
Fluoranthene	BRL	BRL	BRL	450	790	BRL	BRL	1,000,000
Pyrene	BRL	BRL	BRL	380	730	BRL	BRL	700,000
Benzo(a)anthracene	BRL	BRL	BRL	BRL	410	BRL	BRL	700
Chrysene	BRL	BRL	BRL	BRL	520	BRL	BRL	7,000
Benzo(b)fluoranthene	BRL	BRL	BRL	BRL	480	BRL	BRL	700
Benzo(k)fluoranthene	BRL	BRL	BRL	BRL	370	BRL	BRL	7,000
Benzo(a)pyrene	BRL	BRL	BRL	BRL	400	BRL	BRL	700
Indeno(1,2,3-cd)pyrene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	700
Dibenzo(a,h)anthracene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	700
Benzo(g,h,i)perylene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	1,000,000
2-Methylnaphthalene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	4,000

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
µg/kg micrograms per kilogram
Dup sample duplicate
BRL below laboratory reporting limit

Boldface type indicates exceedance of MADEP RCS-1.

Samples analyzed by Groundwater Analytical of Buzzards Bay, MA using EPA Method 8270C.

Table E.6 Results of Subsurface Soil Analysis for Polycyclic Aromatic Hydrocarbons, Russell Field, November 26 – December 2, 2003

Analyte	Sample Location										MADEP RCS-1
	C82-S1P (3' – 6')	C199-S1P (1' – 6')	C199-S4P (6' – 10')	C123-S1P (3.5' – 4.5')	C122-S1P (1' – 7.5')	C122-S2P (7.5' – 9.5')	C116-S1P (1.5' – 6')	C116-S2P (6' – 9.5')	C114-S1P (1' – 6.5')	C114-S1P Dup (1' – 6.5')	
	Concentration (μg/kg)										
Naphthalene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	4,000
Acenapthylene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	100,000
Acenaphthene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	20,000
Fluorene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	400,000
Phenanthrene	390	BRL	BRL	1,000	BRL	BRL	BRL	BRL	BRL	BRL	100,000
Anthracene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	1,000,000
Fluoranthene	760	BRL	BRL	1,400	BRL	BRL	BRL	BRL	BRL	BRL	1,000,000
Pyrene	710	BRL	BRL	1,100	BRL	BRL	BRL	BRL	BRL	BRL	700,000
Benzo(a)anthracene	390	BRL	BRL	580	BRL	BRL	BRL	BRL	BRL	BRL	700
Chrysene	480	BRL	BRL	660	BRL	BRL	BRL	BRL	BRL	BRL	7,000
Benzo(b)fluoranthene	430	BRL	BRL	690	BRL	BRL	BRL	BRL	BRL	BRL	700
Benzo(k)fluoranthene	BRL	BRL	BRL	560	BRL	BRL	BRL	BRL	BRL	BRL	7,000
Benzo(a)pyrene	420	BRL	BRL	**740**	BRL	BRL	BRL	BRL	BRL	BRL	700
Indeno(1,2,3-cd)pyrene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	700
Dibenzo(a,h)anthracene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	700
Benzo(g,h,i)perylene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	1,000,000
2-Methylnaphthalene	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	4,000

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
μg/kg micrograms per kilogram
Dup sample duplicate
BRL below laboratory reporting limit

Boldface type indicates exceedance of MADEP RCS-1.

Samples analyzed by Groundwater Analytical of Buzzards Bay, MA using EPA Method 8270C.

APPENDIX F

DATA TABLES—INORGANICS ANALYSES

Table F.1 Results of Subsurface Soil Analysis for Metals, Russell Field, November 18 – 25, 2003

Analyte	Sample Location													MADEP RCS-1
	C2-S1P	C15-S1P	C9-S1P	C39-S1P	C37-S1P	C21-S1P	C93-S1P	C102-S1P	C102-S1P Dup	C162-S1P	C110-S1P	C110-S3P	C135-S1P	
	Concentration (mg/kg)													
Antimony	1.6	BRL	3.4	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	10
Arsenic	11	3.1	**11**	5.0	4.4	12	1.9	1.9	2.8	2.2	8.1	3.3	8.0	30
Beryllium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	0.7
Cadmium	0.96	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	30
Chromium	18	BRL	BRL	20	BRL	26	BRL	BRL	BRL	BRL	12	BRL	30	1,000
Copper	210	BRL	30	41	BRL	81	BRL	BRL	22	BRL	37	BRL	BRL	1,000
Lead	**710**	11	160	190	62	**400**	BRL	BRL	BRL	22	99	BRL	14	300
Mercury	0.069	BRL	0.13	0.079	0.052	0.25	0.047	BRL	BRL	BRL	0.35	BRL	BRL	20
Nickel	14	14	BRL	28	BRL	25	BRL	BRL	BRL	BRL	13	BRL	21	300
Selenium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	400
Silver	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	100
Thallium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	8
Zinc	200	BRL	BRL	130	54	200	BRL	BRL	BRL	BRL	64	BRL	BRL	2,500

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
mg/kg milligrams per kilogram
Dup sample duplicate
BRL below laboratory reporting limit

Boldface type indicates exceedance of MADEP RCS-1.

Samples analyzed by Groundwater Analytical of Buzzards Bay, MA using test methods for evaluating solid waste, US EPA, SW-846.

Table F.2 Results of Subsurface Soil Analysis for Metals, Russell Field, November 26 – December 2, 2003

Analyte	Sample Location										MADEP RCS-1
	C82-S1P	C199-S1P	C199-S4P	C123-S1P	C122-S1P	C122-S2P	C116-S1P	C116-S2P	C114-S1P	C114-S1P Dup	
	Concentration (mg/kg)										
Antimony	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	10
Arsenic	6.0	20	2.7	5.5	4.7	5.0	14	1.5	3.2	3.8	30
Beryllium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	0.7
Cadmium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	30
Chromium	BRL	BRL	BRL	BRL	BRL	BRL	17	BRL	BRL	BRL	1,000
Copper	25	BRL	BRL	24	BRL	BRL	99	BRL	BRL	BRL	1,000
Lead	59	BRL	BRL	33	26	BRL	86	BRL	58	70	300
Mercury	0.39	BRL	BRL	0.26	0.097	BRL	0.19	BRL	BRL	0.076	20
Nickel	BRL	BRL	BRL	BRL	BRL	BRL	18	BRL	BRL	BRL	300
Selenium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	400
Silver	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	100
Thallium	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	BRL	8
Zinc	BRL	BRL	BRL	BRL	BRL	BRL	91	BRL	BRL	BRL	2,500

MADEP Massachusetts Department of Environmental Protection
RCS-1 Reportable Concentration Soil Category 1
mg/kg milligrams per kilogram
Dup sample duplicate
BRL below laboratory reporting limit

Boldface type indicates exceedance of MADEP RCS-1.

Samples analyzed by Groundwater Analytical of Buzzards Bay, MA using test methods for evaluating solid waste, US EPA, SW-846.

APPENDIX G

ASBESTOS IN AIR DATA

ASBESTOS IN AIR DATA

METEOROLOGICAL CONDITION SUMMARIES

July 8 – 16, 2002

- **July 8, 2002:** Throughout the sampling period, the temperature ranged from 70.1 degrees Fahrenheit (°F) to 90.8 °F, with an average temperature of 84.9 °F. Winds were steady out of the West, ranging from 0 to 19 miles per hour (mph), with an average wind speed of 5.0 mph. The summary of the meteorological conditions is presented in Table G.2.

- **July 9, 2002:** Throughout the sampling period, the temperature ranged from 78.1 °F to 91.4 °F, with an average temperature of 86.3 °F. Winds were steady out of the West-Southwest, ranging from 3 to 15 mph with an average wind speed of 4.3 mph.

- **July 10, 2002:** During this day there was a technical problem that prohibited communication between the weather station and field computer which prevented the logging of weather data. Winds were checked using the weather station approximately every hour and the wind speed and direction were recorded. Throughout the sampling period, winds were steady out of the North-Northeast to the North-Northwest from 4 to 7 mph. The recorded weather station readings are presented in Table G.1.

Table G.1 Recorded Weather Station Observations, Russell Field, Cambridge, Massachusetts, July 10, 2002

Time	Wind Direction	Wind Speed (mph)
08:37	North	6
09:26	North-Northwest	5
09:58	North	7
10:59	North	6
11:47	North-Northwest	4
13:15	North-Northwest	4
14:44	North-Northeast	7
15:40	North-Northeast	6
17:18	Northwest	5

mph miles per hour

- **July 11, 2002:** Throughout the sampling period, the temperature ranged from 59.3 °F to 73.4 °F, with an average temperature of 69.2 °F. Winds were steady out of the West-Northwest ranging from 5 to 25 mph, with an average wind speed of 10.0 mph.

- **July 12, 2002:** Throughout the sampling period, the temperature ranged from 70.3 °F to 84.5 °F, with an average temperature of 78.9 °F. During the day winds were steady out of the North and Northeast during the morning and late afternoon but came out of the Southeast briefly during the early afternoon. Wind speeds ranged from 1 to 11 mph with an average wind speed of 2.7 mph.

- **July 15, 2002:** Throughout the sampling period, the temperature ranged from 75.3 °F to 90.4 °F, with an average temperature of 84.6 °F. During the day winds were steady out of the Southwest, ranging from 1 to 14 mph with an average wind speed of 3.8 mph.

- **July 16, 2002:** Throughout the sampling period, the temperature ranged from 69.6 °F to 83.7 °F, with an average temperature of 76.2 °F. During the day winds were steady out of the North and Northeast, ranging from 2 to 21 mph with an average wind speed of 5.8 mph.

Table G.2 Meteorological Conditions, Russell Field, Cambridge, Massachusetts, July 8 – 12* and July 15 – 16, 2002

Date	Average Temperature (°F)	Average Wind Speed (mph)	Average Wind Direction
July 8, 2002	84.9	5.0	West
July 9, 2002	86.3	4.3	West-Southwest
July 11, 2002	73.4	10.0	West-Northwest
July 12, 2002	78.9	2.7	North
July 15, 2002	84.6	3.8	West-Southwest
July 16, 2002	76.2	5.8	North

°F degrees Fahrenheit
mph miles per hour

* Not including July 10, 2002, due to technical problems.

May 27 – June 5, 2003

- **May 27, 2003:** Throughout the sampling period, the temperature ranged from 51.5 °F to 64.6 °F, with an average temperature of 56.2 °F. Winds were steady out of the Northeast, ranging from 0 to 10 miles per hour (mph), with an average wind speed of 3.8 mph.

- **May 28, 2003:** Throughout the sampling period, the temperature ranged from 57.1 °F to 74.0 °F, with an average temperature of 65.1 °F. During the day, winds were steady out of the West and Northwest during the morning and early afternoon but came out of the Northeast and North-Northeast briefly during the noon hour and again at the end of the sampling period. Wind speeds ranged from 0 to 11 mph with an average wind speed of 2.1 mph.

- **May 29, 2003:** Throughout the sampling period, the temperature ranged from 62.0 °F to 76.9 °F, with an average temperature of 71.2 °F. Winds were steady out of the West-Northwest, ranging from 1 to 17 mph, with an average wind speed of 2.8 mph.

- **May 30, 2003:** Throughout the sampling period, the temperature ranged from 60.6 °F to 79.0 °F, with an average temperature of 69.7 °F. During the early and mid-morning, winds came out of the Northeast but came out of the West-Northwest and North throughout the remainder of the sampling period. Wind speeds ranged from 0 to 13 mph with an average wind speed of 2.8 mph.

- **June 2, 2003:** Throughout the sampling period, the temperature ranged from 57.5 °F to 73.4 °F, with an average temperature of 65.6 °F. During the day, winds were steady out of the Northwest and North-Northwest but came out of the East for a short amount of time during the mid-morning. Wind speeds ranged from 3 to 24 mph with an average wind speed of 6.5 mph.

- **June 3, 2003:** Throughout the sampling period, the temperature ranged from 59.0 °F to 74.4 °F, with an average temperature of 68.7 °F. Winds were steady out of the West-Northwest, ranging from 2 to 18 mph, with an average wind speed of 4.9 mph.

- **June 4, 2003:** Throughout the sampling period, the temperature ranged from 58.6 °F to 70.9 °F, with an average temperature of 66.0 °F. During the early morning, winds came out of the Northeast, switched to the West and Southwest during the late morning and early afternoon and came out of the East during the end of the sampling period. Wind speeds ranged from 1 to 10 mph with an average wind speed of 2.1 mph.

- **June 5, 2003:** On this date, technical problems prevented the weather station from logging data. This problem was not discovered in the field so weather data from this day was obtained from a weather station located approximately one mile from Russell Field in Cambridge, Massachusetts. Throughout the sampling period, the temperature ranged from 54.0 °F to 60.2 °F, with an average temperature of 56.8 °F. During most of the sampling period, winds came out of the North and Northwest, but come out of the East and East-Northeast briefly during the mid-morning. Wind speeds ranged from 1 to 14 mph with an average wind speed of 2.9 mph.

Table G.3 Meteorological Conditions, Russell Field, Cambridge, Massachusetts, May 27 – 30 and June 2 – 5*, 2003

Date	Average Temperature (°F)	Average Wind Speed (mph)	Dominant Wind Direction
May 27, 2003	56.2	3.8	Northeast
May 28, 2003	65.1	2.1	West
May 29, 2003	71.2	2.8	West-Northwest
May 30, 2003	69.7	2.8	Northeast
June 2, 2003	65.6	6.5	North-Northwest
June 3, 2003	68.7	4.9	West-Northwest
June 4, 2003	66.0	2.1	North-Northeast
June 5, 2003	56.8	2.9	North

°F degrees Fahrenheit
mph miles per hour

* On June 5, 2003, meteorological data was obtained from a weather station located near by in Cambridge, Massachusetts because technical problems prevented the on-site weather station from logging data. The other station is located approximately one mile from Russell Field.

November 18 – December 2, 2003

- **November 18, 2003:** Throughout the sampling period, the temperature ranged from 40.0 °F to 64.0 °F, with an average temperature of 53.8 °F. Winds were steady out of the East-Northeast, ranging from 0 to 4 miles per hour (mph), with an average wind speed of 1.5 mph.

- **November 19, 2003:** Throughout the sampling period, the temperature ranged from 42.2 °F to 57.7 °F, with an average temperature of 53.9 °F. Winds were steady out of the East-Southeast, ranging from 1 to 6 mph with an average wind speed of 3.2 mph.

- **November 24, 2003:** Throughout the sampling period, the temperature ranged from 32.5 °F to 75.5 °F, with an average temperature of 57.3 °F. During the day, winds were steady out of the West-Northwest during the early morning, but came out of the East-Northeast during the late afternoon and rest of the day. Wind speeds ranged from 0 to 4 mph with an average wind speed of 2.1 mph.

- **November 25, 2003:** Throughout the sampling period, the temperature ranged from 45.1 °F to 59.0 °F, with an average temperature of 52.8 °F. Winds were steady out of the Southwest ranging from 5 to 11 mph, with an average wind speed of 7.9 mph.

- **November 26, 2003:** Throughout the sampling period, the temperature ranged from 29.7 °F to 56.6 °F, with an average temperature of 44.5 °F. Winds were steady out of the South-Southeast ranging from 0 to 6 mph, with an average wind speed of 3.5 mph.

- **December 1, 2003:** During this day, there was a technical problem that prohibited communication between the weather station and field computer, which prevented the logging of weather data. During the morning, winds were checked using the weather station approximately every hour and the wind speed and direction were recorded. Unfortunately, the heavy wind gusts damaged the weather station and the wind direction could not be determined. Throughout the sampling period, winds were steady out of the South-Southwest from 5 to 15 mph.

Table G.4 Meteorological Conditions, Russell Field, Cambridge, Massachusetts, November 18 through December 2, 2003

Date	Average Temperature (°F)	Average Wind Speed (mph)	Dominant Wind Direction
November 18, 2003	53.8	1.5	East-Northeast
November 19, 2003	53.9	3.2	East-Southeast
November 24, 2003	57.3	2.1	East-Northeast
November 25, 2003	52.8	7.9	Southwest
November 26, 2003	44.5	3.5	South-Southeast
December 1, 2003*	45.5	20.0	West
December 2, 2003*	28.0	19.3	Northwest

°F degrees Fahrenheit
mph miles per hour

* Meteorological conditions obtained from weather data collected at Boston Logan International Airport, MA.

DATA TABLES—ASBESTOS IN AIR

July 8 – 16, 2002

Table G.5 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 8, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
35854	Field blank	BRL
35855	Field blank	BRL
35856	Upwind 8S1	.001
35857	Downwind 8S2	BRL
35858	Downwind 8S3	.001
35859	Sample station 8M1	.001
35860	Drill rig 8M2	.001

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.6 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 9, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
35861	Upwind 9S1	.001
35862	Upwind 9S2	BRL
35863	Downwind 9S3	.001
35864	Downwind 9S4	.001
35865	Downwind 9S5	.001
35866	Drill rig/surface sample 9S6	NA (overloaded)
35867	Sample station 9S7	.001
35868	Field blank	BRL
35869	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3
NA not analyzed

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.7 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 10, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
35870	Field blank	BRL
35871	Field blank	BRL
35872	Upwind 10S1	.001
35873	Upwind 10S2	.002
35874	Downwind near Clifton Path 10S3	.003
35875	Downwind baseball near Clifton 10S4	BRL
35876	Sampling area 10M1	.002
35877	Mobile 10M2	.002

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.8 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 10, 2002, Reanalysis via TEM

Sample ID	Location	Asbestos Fiber Concentration/cm^3
35870	Field blank	BRL
35872	Upwind 10S1	BRL
35873	Upwind 10S2	BRL
35874	Downwind near Clifton Path 10S3	BRL
35875	Downwind baseball near Clifton 10S4	BRL
35876	Sampling area 10M1	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit

Samples reanalyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7402 Transmission Electron Microscopy (TEM).

Table G.9 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 11, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
35878	11S1 upwind	BRL
35879	11S2 upwind	.001
35880	11S3 downwind	BRL
35881	11S4 downwind	BRL
35882	11M1 sample station	BRL
35883	11M2 mobile	.001
45331	Field blank	BRL
45332	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.10 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 12, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
45333	12S1 upwind	BRL
45334	12S2 upwind	.001
45335	12S3 upwind	.001
45336	12S4 downwind	.001
45337	12S5 downwind	BRL
45338	12M1 sample station	.001
45339	12M2 mobile	BRL
45340	Field blank	BRL
45341	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.11 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 15, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
45342	Field blank	ND
45343*	S5 downwind football field/Comeau Field	.002
45344	M2 mobile unit	.001
45345*	M1 sample station	BRL
45346	S1 goalie net—downwind	BRL
45347	S2 upwind Alewife path	.001
45348	S3 upwind parking lot	.001
45349	S4 downwind pool fence	BRL
45350	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

* Sample stations relocated due to changes in work zone and/or prevailing wind direction.

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.12 Air Samples Collected at Russell Field, Cambridge, Massachusetts, July 16, 2002

Sample ID	Location	Total Fiber Concentration/cm^3
45351	S4 downwind Comeau Field	.001
45352	M2 mobile	.001
45353	M1 sample station	.002
45354	S1 upwind parking lot	.001
45356	S3 upwind pool	BRL
45357	Field blank	BRL
45358	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

May 27 – June 5, 2003

Table G.13 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts, May 27, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56737	Drilling rig, B4	NA (overloaded)
56738	Downwind of B4	ND
56739	Downwind of B4	ND
56740	Upwind of B4	ND
56741	Field blank	ND
56742	Field blank	ND

cm^3 cubic centimeter
NA not analyzed
ND none detected

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.

Table G.14 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts, May 28, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56743	Drilling rig, B4	NA (Overloaded)
56744	Downwind, path side B4	0.001
56745	Downwind B4, ball field	ND
56746	Upwind B4, CRZ	ND
56747	Field blank	ND
56748	Field blank	ND

cm^3 cubic centimeter
NA not analyzed
ND none detected
CRZ contaminant reduction zone

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.
Clearance criteria: ≤0.01 total f/cm^3, aggressive air sampling technique.

Table G.15 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts, May 29, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56749	Drilling rig, B2 and B1	NA (Overloaded)
56750	Downwind, right field (B2), baseball backstop (B1)	0.001
56751	Downwind, left field (B2), Goal post (B1)	0.001
56752	Upwind, B2 and B1	ND
56753	Field blank	ND
56754	Field blank	ND

cm^3 cubic centimeter
NA not analyzed
ND none detected

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.
Clearance criteria: ≤0.01 total f/cm^3, aggressive air sampling technique.

Table G.16 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts, May 30, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56755	Drilling Rig, B1 and B5	NA (Overloaded)
56756	Downwind, right (B1) and center (B5) baseball field	0.002
56757	Downwind, center (B1) and left (B5) baseball field	0.001
56758	Upwind, Goal post football field B1 and B5	0.001
56759	Field Blank	ND
56760	Field Blank	ND

cm^3 cubic centimeter
ND none detected
NA not analyzed

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.

Table G.17 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts, June 2, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56761	Downwind, baseball dugout (B6), football field (B9)	0.001
56762	Downwind, backstop (B6), goal post (B6)	0.001
56763	Upwind, light post bike path (B6), bike path (B9)	0.002
56764	Drilling rig, B6 and B9	0.001
56765	Field blank	ND
56766	Field blank	ND

cm^3 cubic centimeter
ND none detected

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.
Clearance criteria: ≤0.01 total f/cm^3, aggressive air sampling technique.

Table G.18 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts on June 3, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56767	Drilling rig, B7 and B8	ND
56768	Downwind, B7, east fence B8	ND
56769	Downwind B7, outside gate B8	ND
56770	Upwind, B7, behind football goal B8	ND
56771	Field blank	ND
56772	Field blank	ND

cm^3 cubic centimeter
ND none detected

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.
Clearance criteria: ≤0.01 total f/cm^3, aggressive air sampling technique.

Table G.19 Asbestos Air Samples Collected at Russell Field, Cambridge, Massachusetts on June 3, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
56767	Drilling rig, B7 and B8	ND
56768	Downwind, B7, east fence B8	ND
56769	Downwind B7, outside gate B8	ND
56770	Upwind, B7, behind football goal B8	ND
56771	Field blank	ND
56772	Field blank	ND

cm^3 cubic centimeter
ND none detected

Samples analyzed by ProScience Analytical Services, Inc, Woburn, MA.
Method: NIOSH 7400 phase-contract microscopy.
Clearance criteria: ≤0.01 total f/cm^3, aggressive air sampling technique.

November 18 – December 2, 2003

Table G.20 Air Samples Collected at Russell Field, Cambridge, Massachusetts, November 18, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
111803-S1	Downwind Station 1	NA (overloaded)
111803-S2	Downwind Station 2	NA (overloaded)
111803-S3	Downwind Station 3	NA (overloaded)
111803-S4	Worker Station 4	NA (overloaded)
111803-S4 Dup	Worker Station 4 Dup	NA (overloaded)
111803-S5	Upwind Station 5	NA (overloaded)

cm^3 cubic centimeter
NA not analyzed
Dup sample duplicate

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.21 Air Samples Collected at Russell Field, Cambridge, Massachusetts, November 19, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61957	Worker Station 4	BRL
61958	Downwind Station 1	BRL
61959	Downwind Station 2	BRL
61960	Downwind Station 3	BRL
61961	Upwind Station 5	BRL
61962	Field Blank	BRL
61963	Field Blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.22 Air Samples Collected at Russell Field, Cambridge, Massachusetts, November 24, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61964	Downwind Station 1	NA (overloaded)
61965	Downwind Station 2	NA (overloaded)
61966	Upwind Station 3	NA (overloaded)
61967	Downwind Station 4	NA (overloaded)
61968	Worker Station 5	NA (overloaded)
61969	Worker Station 5 Dup	NA
61970	Field Blank	BRL
61971	Field Blank	BRL

cm^3 cubic centimeter
NA not analyzed
Dup sample duplicate
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.23 Air Samples Collected at Russell Field, Cambridge, Massachusetts, November 25, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61972	Downwind Station 1	BRL
61973	Downwind Station 2	BRL
61974	Downwind Station 3	BRL
61975	Upwind Station 4	BRL
61976	Worker Station 5	BRL
61977	Field blank	BRL
61978	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.24 Air Samples Collected at Russell Field, Cambridge, Massachusetts, November 26, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61979	Downwind Station 2	BRL
61980	Downwind Station 1	BRL
61981	Upwind Station 4	BRL
61982	Downwind Station 3	BRL
61983	Worker Station 5	BRL
61984	Field blank	BRL
61985	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.25 Air Samples Collected at Russell Field, Cambridge, Massachusetts, December 1, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61986	Downwind Station 1	BRL
61987	Downwind Station 2	0.001
61988	Downwind Station 3	0.001
61989	Upwind Station 4	BRL
61990	Worker Station 5	0.001
61991	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.26 Air Samples Collected at Russell Field, Cambridge, Massachusetts, December 2, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61992	Downwind Station 1	0.001
61993	Downwind Station 2	BRL
61994	Downwind Station 3	BRL
61995	Upwind Station 4	BRL
61996	Worker Station 5	BRL
61997	Field blank	BRL
61998	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

Table G.27 Air Samples Collected at Russell Field, Cambridge, Massachusetts, December 2, 2003

Sample ID	Location	Total Fiber Concentration/cm^3
61992	Downwind Station 1	0.001
61993	Downwind Station 2	BRL
61994	Downwind Station 3	BRL
61995	Upwind Station 4	BRL
61996	Worker Station 5	BRL
61997	Field blank	BRL
61998	Field blank	BRL

cm^3 cubic centimeter
BRL below laboratory reporting limit of .001 cm^3

Samples analyzed by ProScience Analytical Services, Inc., Woburn, MA.
Method: NIOSH 7400 Phase Contrast Microscopy (PCM).

IMMINENT HAZARD ASSESSMENT

The Massachusetts Department of Environmental Protection (MADEP) Guidance for Disposal Site Risk Characterization provides two approaches for Imminent Hazard Evaluation. A 30-year exposure duration is typically selected for carcinogens. If a 30-year exposure is modeled, the recommended criterion for Excess Lifetime Cancer Risk (ELCR) is one in ten thousand or 10^{-4}. If a shorter exposure duration is selected (one to five years) the limit is one in one hundred thousand or 10^{-5}. The 30-year exposure duration is appropriate for this contaminant (asbestos)—which is a carcinogen.

Alternatively, because of the short duration of proposed field renovations, a one- to five-year exposure could also be considered appropriate.

The EPA Inhalation Unit Risk is 2.3×10^{-1} asbestos f/ml or 0.0004 asbestos f/ml at 10^{-4} ELCR. This is based upon a 70-year lifetime exposure. Therefore:

30-year exposure to 0.0009 asbestos f/ml = 10^{-4} ECLR
1-year exposure to 0.0028 asbestos f/ml = 10^{-5} ECLR
5-year exposure to 0.0006 asbestos f/ml = 10^{-5} ECLR

An action level was developed for the sampling program. If it had been exceeded, work would have stopped and samples for the day that the exceedance occurred would have been reanalyzed via transmission electron microscopy (TEM) analysis. No exceedances were detected.

Based upon risk thresholds, reported background concentrations, and analytical detection limits, a conservative action level of 0.003 f/ml (total fibers) was established for perimeter monitoring locations during the course of field work. This level is roughly equivalent to the upper range of reported urban background concentrations for asbestos and the acceptable risk level for a one-year exposure, assuming that all fibers detected were asbestos. This concentration is above the 0.001 f/ml detection limit of phase contrast microscopy (PCM) analysis. Direct use of PCM results added a significant safety factor because PCM provides a count of all fiber types, not just asbestos. As previously noted, reanalysis of samples collected on July 10, 2002 by TEM did not detect asbestos.

The average of downwind locations less the average upwind concentration was calculated for comparison to the action level. This represents potential contributions of fibers from Russell Field to ambient air. Based upon the results listed in Tables G.28 and G.29, it can be seen that this action level was not exceeded during the course of the sampling program. On two days, average upwind concentrations exceeded downwind concentrations.

In fact, only one individual sample (collected on July 10, 2002) equaled the action level for total fibers (but did not exceed it). Reanalysis of this sample by TEM did not detect asbestos.

Table G.28 Calculation of Exposure Point Concentrations—Russell Field Perimeter (total f/cm^3)

Date	Perimeter Average—Upwind	Perimeter Average—Downwind*	Exposure Point Concentration (Upwind – Downwind)**
7/8/02	0.0010	0.0008	–0.0002
7/9/02	0.0008	0.0010	0.0002
7/10/02	0.0015	0.0018	0.0003
7/11/02	0.0008	0.0005	–0.0003
7/12/02	0.0008	0.0008	0
7/15/02	0.0010	0.0010	0
7/16/02	0.0008	0.0010	0.0002
Average	*0.0010*	*0.0010*	*0.00003*

* For samples with no detected fibers, a value of 0.0005 f/cm^3 (½ the detection limit) was used for calculations.
** Concentrations calculated are below the actual detection limit of 0.001 and are a result of averaging.

Because Imminent Hazard is based upon longer-term exposures, the Exposure Point Concentration (EPC) for the Imminent Hazard Assessment was based upon all of the perimeter air monitoring data collected during this program. For samples with no detectable fibers, a value of half the detection limit was used for these calculations. Based upon PCM analyses, the average upwind perimeter concentration was 0.001 and the average downwind perimeter concentration was 0.001. Therefore, the EPC of total fibers attributable to Russell Field was well below method detection limits and based upon the absolute difference of the averages, approximately 0.00003. Therefore, even making the very conservative assumption that all fibers attributable to Russell Field were asbestos, no Imminent Hazard is indicated for a 30-year nor a 1- to 5-year exposure.

An even more conservative approach utilizes an average of all downwind samples (including sampling stations) in the EPC calculation. As indicated in Table G.29, the calculated average downwind concentration using these assumptions is 0.0011 and the EPC is 0.0001. Again, the EPC is well below the action levels and no Imminent Hazard is indicated.

Table G.29 Calculation of Exposure Point Concentrations—Russell Field All Locations (total f/cm^3)

Date	Perimeter Average—Upwind	Perimeter Average—Downwind	Exposure Point Concentration (Upwind – Downwind)
7/8/02	0.0010	0.0009	–0.0001
7/9/02	0.0008	0.0010	0.0002
7/10/02	0.0015	0.0019	0.0004
7/11/02	0.0008	0.0006	–0.0002
7/12/02	0.0008	0.0008	0
7/15/02	0.0010	0.0009	–0.0001
7/16/02	0.0008	0.0013	0.0005
Average	*0.0010*	*0.0011*	*0.0001*

Work area monitoring stations are subject to the Imminent Hazard Action Level and Occupational Safety and Health Administration permissible exposure limits (PELs). The PEL for worker safety is 0.10 asbestos f/ml. All measured fiber and asbestos concentrations were below this limit.

APPENDIX H

2002 BORING LOGS

APPENDIX I

NOVEMBER – DECEMBER 2003 BORING LOGS

APPENDIX J

GEOTECHNICAL ASSESSMENT REPORT AND BORING LOGS

APPENDIX K

LABORATORY REPORTS—SOIL

APPENDIX L

ANI ANALYTICAL REPORTS

APPENDIX M

LABORATORY REPORTS—ASBESTOS AIR SAMPLING DATA

APPENDIX N

RISK ASSESSMENT TABLES

APPENDIX O

MODEL INFORMATION

APPENDIX P

ASBESTOS REANALYSIS RESULTS— RISK ASSESSMENT