SDMS DocID 287402

Massachusetts Military Reservation

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Air Force Center for
Engineering and the Environment

Final Record of Decision for Chemical Spill-10 Groundwater

August 2009

Prepared for:
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Document No.: A4P-J23-35BC02VA-M26-0018

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ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
ANGI	Air National Guard Instruction
ARAR	applicable or relevant and appropriate requirement
BEHP	bis(2-ethylhexyl) phthalate
BOH	Board of Health
BOMARC	Boeing Michigan Aerospace Research Center
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CS	chemical spill
COC	contaminants of concern
COPC	chemicals of potential concern
COPEC	chemical of potential ecological concern
CS-10	Chemical Spill-10
DAD	dermal absorbed dose
DCM	decision criteria matrix
DOD	U.S. Department of Defense
EDB	ethylene dibromide
EL	Eastern Lobe
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration

ACRONYMS AND ABBREVIATIONS

ERA	ecological risk assessment
ETI	extraction, treatment, and infiltration
ETR	extraction, treatment, and reinjection
FFA	Federal Facility Agreement
FS-#	Fuel Spill-#
FS	feasibility study
ft msl	feet mean sea level
GAC	granular activated carbon
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISCO	In-Situ Chemical Oxidation
lb	pound
LTM	long-term monitoring
LUC	land use control
M	million
MassDEP	Massachusetts Department of Environmental Protection
MCL	maximum contaminant level
mg/kg-day	milligrams per kilogram per day
MMR	Massachusetts Military Reservation

ACRONYMS AND ABBREVIATIONS

MMRCT	Massachusetts Military Reservation Cleanup Team
MPP	Mashpee Pitted Plain
NCL	North Central Lobe
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NGB	National Guard Bureau
NL	Northern Lobe
NPL	National Priorities List
O&M	Operations and Maintenance
OU	operable unit
PCE	tetrachloroethene
PCT	Plume Cleanup Team
PP	proposed plan
PRA	preliminary risk assessment
PRB	permeable reactive barrier
PRG	preliminary remediation goal
RAGs D	Risk Assessment Guidance for Superfund Part D
RAO	remedial action objective
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SD-5	Storm Drain-5
SF	slope factor
SI	site investigation

ACRONYMS AND ABBREVIATIONS

SL	Southern Lobe
SRTF	Sandwich Road Treatment Facility
TCE	trichloroethene
TRET	Technical Review and Evaluation Team
TRV	toxicity reference value
USCG	U.S. Coast Guard
UTES	Unit Training Equipment Site
VOC	volatile organic compound
µg/L	micrograms per liter

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1.0 DECLARATION

1.1 SITE NAME AND LOCATION

The Massachusetts Military Reservation (MMR) on Cape Cod, Massachusetts is located within the boundaries of the towns of Bourne, Mashpee, Sandwich, and Falmouth (Figure 1-1). This site is listed on the National Priorities List (NPL) as Otis Air National Guard/Camp Edwards in Falmouth, Massachusetts. This Record of Decision (ROD) addresses Chemical Spill-10 (CS-10) groundwater. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) number for the MMR site is MA2570024487.

1.2 STATEMENT OF BASIS AND PURPOSE

This ROD presents the selected remedy for CS-10 groundwater, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for this site. The CS-10 source areas have been addressed as separate operable units (OU) and will not be addressed in this ROD.

The U.S. Department of Defense (DOD) (U.S. Air Force) is the lead agency for CERCLA remedial actions at the MMR. The U.S. Environmental Protection Agency (EPA), the U.S. Air Force, and the National Guard Bureau (NGB) are parties to the Federal Facility Agreement (FFA) (EPA et al. 2002) for this site. They, along with the Massachusetts Department of Environmental Protection (MassDEP), concur with the selected remedy.

1.3 ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF SELECTED REMEDY

The selected remedy for CS-10 groundwater provides for continued active treatment of the CS-10 plume using the existing extraction, treatment, and reinjection (ETR) and extraction, treatment, and infiltration (ETI) systems plus a new extraction well and reinjection well southeast of the Southern Infiltration Trench. The objective of this remedy is to continue to operate, maintain, and optimize the existing ETR/ETI systems with additional treatment in the Southern Trench area to expedite aquifer restoration, and implement land use controls (LUC) to prevent residential exposure to the CS-10 plume. The ETR/ETI systems consist of extracting and treating groundwater to federal and state standards for trichloroethene (TCE) and tetrachloroethene (PCE) as stipulated in the current Operations and Maintenance (O&M) Plan. This remedy leaves open the possibility of modifying the treatment system to optimize the efficiency of the systems and the cleanup time frame. This remedy will also provide for chemical and hydraulic monitoring of the plume as long as active remediation continues. After active ETR/ETI becomes no longer effective at expediting plume cleanup, the Air Force Center for Engineering and the Environment (AFCEE), with regulatory agency concurrence, may cease operation of the ETR/ETI systems and will continue to monitor the residual plume contamination until the remedial action objectives (RAO) have been met. The monitoring of the plume will be conducted as part of the system performance and ecological impact monitoring (SPEIM) program. This remedy provides the flexibility of modifying the monitoring network as necessary to adequately monitor the CS-10 plume and optimize system performance. LUCs will prevent potential human exposure to contaminated groundwater. Five-year reviews and a residual risk assessment will be performed to determine if the remedy is still appropriate and protective.

1.5 STATUTORY DETERMINATIONS

The selected CS-10 groundwater remedy is protective of human health and the environment, complies with federal and Commonwealth of Massachusetts requirements that are applicable or relevant and appropriate requirements (ARAR) for the remedial action, utilizes permanent solutions to the maximum extent possible, and is cost-effective. The remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). Because hazardous substances are expected to remain in the aquifer for a number of years above levels that allow for unlimited use and unrestricted exposure, five-year reviews and a residual risk assessment will be conducted to ensure that the remedies continue to be protective of human health and the environment.

1.6 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section (Section 2.0) of this ROD. Additional information can be found in the Administrative Record for this site.

Data Item	Location in Document
Contaminants of Concern (COC) and their respective concentrations.	Section 2.5.1
Baseline risk represented by the COCs.	Section 2.7
Cleanup levels established for the COCs and the basis for these levels.	Section 2.8
How source materials constituting principal threats will be addressed.	Section 2.2
Current and reasonable anticipated future land use assumptions and current and potential future beneficial use of groundwater used in the baseline risk assessment and the ROD.	Section 2.6

Data Item	Location in Document
Potential land and groundwater use that will be available at the site as a result of the selected remedy.	Section 2.8
Estimated annual and total present value costs, discount rate, and the number of years over which the remedy cost estimate is projected.	Section 2.11.3
Key factor(s) that led to selecting the remedy.	Sections 2.10.2 and 2.12

1.7 AUTHORIZING SIGNATURES

The foregoing represents the decision for remedial action for CS-10 groundwater by AFCEE and the EPA, with the concurrence of the MassDEP.

Approve and recommend for immediate implementation.

AIR FORCE CENTER FOR ENGINEERING AND THE ENVIRONMENT

By: _____ Date: 2 AUG 09

Dennis M. Firman, P.E.
Director

U.S. ENVIRONMENTAL PROTECTION AGENCY

By: _____ Date: 8 19 09

for **James T. Owens III**
Director, Office of Site Remediation and Restoration

2.0 DECISION SUMMARY

The following sections describe the setting, potential risks, RAOs, and alternative evaluation for remediation of CS-10 groundwater.

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The MMR is listed on the NPL as Otis Air National Guard/Camp Edwards in Falmouth, Massachusetts. The CERCLIS number for the MMR site is MA2570024487. In accordance with Executive Order 12580, the DOD is the lead agency for remedial actions at the MMR. The MMR was formally added to the NPL in 1989. The FFA for the MMR site was signed in 1991 by the DOD, the EPA, and the U.S. Coast Guard (USCG)/Department of Transportation[1] (EPA et al 2002). The Commonwealth of Massachusetts chose not to be a signatory to the FFA. In 1995, the FFA was amended to add the U.S. Air Force as the lead agent for the cleanup at MMR. The FFA, as amended, requires the U.S. Air Force to implement CERCLA requirements at the MMR (EPA et al. 2002).

The MMR occupies approximately 22,000 acres on Cape Cod (Figure 2-1) and consists of several operating command units: the Air National Guard, the Army National Guard, the Air Force, the USCG, and the Department of Veteran Affairs. Military training and maneuvers, military aircraft operations, and maintenance and support activities have resulted in past releases of hazardous materials at the MMR. CS-10 is located on the south side of the MMR (Figure 2-1). The CS-10 groundwater plume is identified as OU ID 14, OU 01B – CS-10 GW SANDWICH ROAD, OU ID 21, OU 01H – CS-10 GW IN-PLUME, and OU ID 22, OU 01I – CS-10 GW SOUTHWEST/SOUTH in the EPA database.

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[1] In 2000, the FFA was amended to remove the USCG/U.S. Department of Transportation as a signatory to the FFA.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Military use at the MMR began in 1911. The most intense periods of activity occurred from 1940 to 1946 and 1955 to 1970. Sources of contamination and chemical spills (CS) resulting from a variety of military operations include motor pools, landfills, fire training areas, and drainage structures such as dry wells and drainage swales.

The MMR history consists of a series of complex interactions between various federal agencies and the Commonwealth of Massachusetts. In 1940, the U.S. Army signed a 99-year lease with the Commonwealth of Massachusetts for the use of the MMR. The Army transferred this lease to the Air Force in 1953 for the Otis Air Force Base portion of the military reservation, and the Army maintained a sublease for the 14,000-acre area on the base known as Camp Edwards. In 1974, the Air Force licensed the Massachusetts Air National Guard to use Otis Air Force Base, and in 1975, the U.S. Army licensed the Massachusetts Army National Guard to use and occupy Camp Edwards. On 05 March 2002, a law was enacted to designate the northern 15,000 acres of the MMR as protected conservation land dedicated for the purposes of water supply and wildlife habitat, at the same time allowing military training compatible with the environmental protection of the land. In 2003, the Commonwealth of Massachusetts extended the lease with the National Guard until 2051.

Activities resulting in CERCLA actions are summarized below. In 1982, the DOD initiated the Installation Restoration Program (IRP) at the Otis Air National Guard Base area of the MMR. The IRP at the MMR is funded by the Defense Environmental Restoration Account. The NGB was responsible for implementing the IRP at the MMR. In 1986, the IRP was expanded to include all potential hazardous waste sites at the MMR. In 1989, the MMR was formally added to the NPL. An FFA among the NGB, the EPA, and the USCG was signed in 1991 and has since been amended (EPA et al. 2002). The FFA provides a framework for EPA oversight and enforcement of the MMR investigations and cleanup activities and identifies a schedule for cleanup activities. A Community Relations plan is included as an attachment to the FFA. In 1996, the regulatory agencies requested that the DOD provide a new management structure for the

MMR IRP. In response to that request, the U.S. Air Force assumed the lead role in the execution of the IRP and assigned AFCEE to manage the program. Under Amendment 2, additional enforceable milestones and the Plume Response Decision Criteria and Schedule were added to the FFA. Amendment 3 removed the USCG from its status as a party to the FFA because the USCG had not played an active role in implementing cleanup obligations under the FFA. Amendment 4 added Section 7003 of the Resource Conservation and Recovery Act to the FFA in order to address contamination caused solely by petroleum releases that fall within the scope of the CERCLA "petroleum exclusion" described in the last sentence of CERCLA Section 101(14). In June 2002, Amendment 5 was signed and removed the CS-13 site from the list of Study Areas and Areas of Contamination contained in Section 5.24 of the FFA. After investigation of the historical usage of the CS-13 site, it was removed based on a lack of evidence to indicate that any military component currently is or had been either an owner or operator of the site (i.e., real property comprising CS-13) as defined under CERCLA and the NCP.

The CS-10 plume was formed from numerous sources. The main source area is the former Boeing Michigan Aerospace Research Center (BOMARC) facility, including the Unit Training Equipment Site (UTES) (Figure 2-2). Numerous other sources of contamination are presumed to have contributed to the CS-10 plume as it traveled beneath the cantonment area of the MMR.

In 1985, an investigation of the possible impact of UTES/BOMARC activities on local groundwater quality detected several chlorinated organics in the groundwater (AEHA 1988). A site investigation (SI) conducted from 1986 to 1988 identified numerous contamination sources in the BOMARC area and detected contaminants in the soil (fuel- and oil-related polynuclear aromatic hydrocarbons, pesticides, polychlorinated biphenyls, and inorganics) and groundwater (halogenated solvents cis-1,2-dichloroethene, TCE, and PCE). Based on the results of the SI, a remedial investigation (RI) was performed. An interim RI was conducted in 1989 and 1990 to investigate suspected sources of groundwater contamination, determine the extent of groundwater contamination, and determine the significance of facility storm sewers as contaminant

migration pathways (ABB 1992b). An RI was conducted for the UTES/BOMARC area fuel spill area of concern CS-10/Fuel Spill-24 (FS-24) source OUs (CDM 1997) and a separate RI was conducted for the groundwater plume (CDM 1996), which, at the time, was only defined north of Ashumet Pond. Numerous data gap investigations were conducted on the main body of the plume in support of remedial actions.

Leading edge investigations of the CS-10 plume began in 1997, the first of which determined that the CS-10 plume had migrated beneath Ashumet Pond and that the plume (primarily TCE) was detected between Ashumet and Johns Ponds (Figure 2-2). The TCE lobe [later named the Northern lobe (NL)] was initially identified in 1998 through a vapor diffusion survey in Johns Pond followed by on-pond drilling and land-based drilling (AFCEE 2001B). In 1999 and 2000, the nature and extent of the CS-10 plume under Ashumet Pond was investigated through vapor diffusion sampling and on-pond drilling. The North Central lobe (NCL) and Southern lobe (SL) were initially delineated as part of the RI conducted in 2000 and 2001 (AFCEE 2001b). The RI focused on the leading edge of the CS-10 plume downgradient of Sandwich Road.

A CS-10 groundwater feasibility study (FS) was conducted in 2002 to 2003 (AFCEE 2003b), which addressed the main body and the leading edge of the plume. In late 2003, a preferred remedy was identified and an initial draft proposed plan (PP) was issued for regulatory agency review in January 2004. In February 2004, AFCEE and the regulatory agencies agreed to put the PP on hold so that a field investigation to better characterize the leading edge lobes of the CS-10 plume could be conducted (AFCEE 2005a). The CS-10 groundwater FS addendum was then prepared with updated information for the main body and the leading edge of the CS-10 plume (AFCEE 2007a). In late 2006, a preferred remedy was identified and a second draft PP was issued for regulatory review in November 2006 (AFCEE 2006a). When contamination southeast of the Southern Infiltration Trench was discovered to be inconsistent with the conceptual model, AFCEE and the regulatory agencies once again agreed to put the PP on hold so that a field investigation to better characterize the portion of the main body of the CS-10 plume that is southeast of the Southern Infiltration Trench could be conducted

(AFCEE 2008b). The data collected during the Southern Trench investigation were used to update the groundwater modeling tools used to evaluate the performance of remedial alternatives in the supplement to the CS-10 FS addendum (AFCEE 2008a). This supplement solely addressed the main body of the CS-10 plume.

The FS, FS addendum, and the supplement to the FS addendum evaluated a range of remedial alternatives. Based on the evaluation of the remedial alternatives, a preferred remedy was presented in the third draft PP, which was finalized in 2009 (AFCEE 2009b). The preferred remedy presented in the finalized PP (AFCEE 2009b) was selected as the final remedy.

2.2.1 Summary of CS-10 Soil Remedial Activities

All known sources for the CS-10 plume have been or are being addressed by the remedial actions. Under the IRP, a sump removal action program was conducted, which included phased investigations consisting of collection and analysis of structure contents and surrounding soils (ABB 1992a). In 1995, drainage structures were either closed in place with concrete fill, delisted as a result of conditions encountered in the field, or removed and the site closed based on post-excavation confirmation sampling (Harding Lawson 1999). As part of the entire structure removal program, which included structures outside of CS-10, 700 cubic yards of soils were removed.

A ROD for Area of Contamination CS-10/FS-24 source areas was finalized in 1999 (AFCEE 1999c). Discrete areas within the source were identified in the ROD as requiring remedial action. Contaminated surface soils (263 cubic yards) were removed from multiple areas (AFCEE 2003a). A thermally enhanced soil vapor extraction system operated from 2002 until 2005 to remove PCE and total petroleum hydrocarbons from the vadose zone associated with a former 300-gallon jet propellant fuel underground storage tank (AFCEE 2005b).

Site-specific removal/remedial activities have also been conducted for many other identified sources believed to have contributed to the CS-10 plume. At CS-4, 13,235 tons

of soil were excavated and thermally treated to eliminate sources of contamination to groundwater (Harding Lawson 1999). Activities at FS-19 included emptying and removing six underground storage tanks. A 3,000-gallon underground storage tank was removed from USCG/FS-26 (Mason Environmental Services 1992). Sumps were removed at CS-1 and CS-2 (ABB 1992a).

2.2.2 Summary of CS-10 Interim Groundwater Remedial Activities

The Department of Defense and the EPA, with concurrence from the MassDEP, implemented an interim action for the CS-10 groundwater plume (and six other MMR plumes). The decision to proceed directly to an interim action (plume containment) for the CS-10 plume is presented in the *Final Record of Decision for Interim Action Containment of Seven Groundwater Plumes at Massachusetts Military Reservation, Cape Cod, Massachusetts* (commonly referred to as the Interim Record of Decision or IROD) (ANG 1995). The selected remedy involved extraction of contaminated groundwater at the leading edge of the plume and discharge of treated water to the groundwater (and/or other beneficial use) and institutional controls.

The Technical Review and Evaluation Team (TRET) reviewed wellfield designs that were developed after the IROD and determined that the 60-percent design (OpTech 1994) for containment of several of the IROD plumes would cause unacceptable ecological impacts (TRET 1996). The remedy for CS-10 was revised through the decision criteria matrix (DCM) process, which included public participation. The process used decision criteria that focused on protection of human health and the environment, regulatory requirements, effectiveness of treatment technologies, and community acceptance to achieve consensus on the selection of an interim remedial action.

The plume response decisions reached as part of the DCM process included active treatment for the plume upgradient of Ashumet Pond. The selected alternative (AFCEE 1997) relied on ETR/ETI technology to capture contaminated groundwater using an extraction fence along Sandwich Road and additional extraction wells within the body of the plume.

The Sandwich Road ETR system, which began operation on 18 May 1999, consisted of eight extraction wells and six reinjection wells operating at a design flow rate of 820 gallons per minute (gpm) (Figure 2-2). The water is processed through granular activated carbon (GAC) units at the Sandwich Road Treatment Facility (SRTF). As a result of system performance assessments and design refinements/optimizations, the current design flow rate is 770 gpm and the number of operating extraction wells has been reduced to six (AFCEE 2009a). Approximately 1001.5 pounds (lb) of TCE and PCE have been removed and approximately 0.4 billion gallons of groundwater were treated since system start-up through December 2008 (AFCEE 2009a).

The CS-10 In-Plume groundwater remedial system was started up on 24 June 1999, and on 27 April 2000, the In-Plume system was supplemented with the start-up of the Southwest/Southern system for a total system design flow of 2,700 gpm, eight extraction wells, and two infiltration trenches (Figure 2-2). The water is processed through GAC units at the CS-10 In-Plume treatment plants. As a result of system performance assessments and design refinements/optimizations, the current design flow rate is 2,758 gpm from nine extraction wells (AFCEE 2009a). Approximately 3,868.1 lb of TCE and PCE combined have been removed and approximately 1.4 billion gallons of groundwater were treated since system start-up through December 2008 (AFCEE 2009a).

The DCM process also committed AFCEE to further investigation of the area downgradient of Sandwich Road and the northwest shoreline of Ashumet Pond. As part of the investigations, lobes of the CS-10 plume were delineated under Ashumet Pond and between Ashumet and Johns Ponds. Due to the high concentrations of TCE detected within the NL (originally referred to as the TCE plume) and the knowledge that it was discharging into Johns Pond, remediation proceeded under a time-critical removal action separate from the DCM process (AFCEE 2000).

The NL remedial system began operation on 22 January 2000 with one extraction well operating at 75 gpm. The groundwater is piped to the SRTF, and the treated water is returned to the aquifer through the Storm Drain-5 (SD-5) reinjection wells. The current

optimized design flow rate is 175 gpm (AFCEE 2009a). Approximately 200 lbs of TCE combined have been removed and approximately 89 million gallons of groundwater were treated since system start-up through December 2008 (AFCEE 2009a).

Other groundwater remedial activities, in addition to those addressed by the DCM process, have been implemented in the CS-10 plume. The first was a pilot test of recirculating wells that was conducted just north of Sandwich Road (Figure 2-2) (AFCEE 1999b). The two pilot systems were operated by AFCEE from December 1996 until just before the Sandwich Road extraction fence went on-line on 18 May 1999. During the operation of the recirculating wells, approximately 313 lbs of TCE were removed (AFCEE 1999b).

In June 1998, two parallel reactive walls composed of zero-valent iron were installed just downgradient of the UTES/BOMARC area (Figure 2-2). The reactive walls were a demonstration project, which showed hydrofracturing to be a successful installation approach. The results of the performance of the walls were inconclusive as the guar in the slurry used to install the zero-valent iron wall never degraded (thus the wall was impermeable) so no assessment of effectiveness could be made (IGR 2001).

In 2007, an In-Situ Chemical Oxidation (ISCO) Pilot Test was conducted within the main body of the plume (Figure 2-2). The pilot test was conducted to evaluate the potential application for ISCO (using permanganate) technology (AFCEE 2007b). An evaluation of the pilot test will be presented in a project note, which is currently scheduled for submittal in summer 2009.

Since the supplement to the FS addendum was completed, the Air Force has designed, constructed, and operated (initiated February 2009) the new extraction and reinjection wells represented by the selected remedy (Figure 2-2). The total In-Plume extraction and reinjection/infiltration rate is 2370 gpm. The Sandwich Road and NL extraction and reinjection rate is 1045 gpm.

2.3 COMMUNITY PARTICIPATION

The MMR IRP has a community involvement program that provides opportunities for the public to become involved in the investigation and decision-making process. Public meetings and poster board sessions are held, display ads and notices are placed in newspapers to announce significant events, public comment periods and meetings, news releases are issued, tours of the sites and treatment facilities are conducted, and neighborhood notices are distributed to notify people of events impacting their neighborhoods.

In addition, several citizen teams have been formed over the years to advise the IRP and the regulatory agencies. Currently the Senior Management Board (SMB) and the Massachusetts Military Reservation Cleanup Team (MMRCT) are the two teams that continue to meet. The MMRCT was formerly known as the Plume Cleanup Team (PCT) and also formerly know as the Joint Plume Action Team. They are made up of citizen volunteers and government representatives working together to resolve problems and advise on the cleanup process. All citizen team meetings are open to the public. Assumptions about reasonably anticipated future land use and potential beneficial uses of groundwater and surface water are regularly discussed.

The public has been kept up-to-date over the years on the progress of the CS-10 plume through various public and citizen team meetings and public notices. The following updates on the IROD to ROD process for this ROD were presented to the MMRCT/PCT:

- 14 March 2007: Presentation on the CS-10 Groundwater FS Addendum.
- 14 May 2008: Overview of the CS-10 plume, remedial systems, and PP and ROD schedules.
- 19 November 2008: Overview of the CS-10 Groundwater PP.

From 08 January to 06 February 2009, AFCEE held a 30-day comment period to obtain public comments on the remedies presented for the CS-10 groundwater in a PP. A presentation of the CS-10 PP was made to the PCT on 19 November 2008, and AFCEE

held a public meeting at the Barnstable Fairgrounds on 07 January 2009 to present the PP. Before the public comment period, the PP was delivered to the town libraries in Bourne, Falmouth, and Sandwich, Massachusetts; the State Library of Massachusetts; and the Wilkens Library at Cape Cod Community College. The PP has also been made part of the Administrative Record available for public review at the AFCEE IRP office at the MMR and on the MMR website, http://www.mmr.org. On 05 February 2009, AFCEE held a public hearing at the Barnstable Fairgrounds to accept formal public comments on the PP. A transcript of the public hearing is provided in Appendix B. One verbal comment was presented at the meeting. AFCEE's response to written comments received during the public comment period is included in the Responsiveness Summary, which is Section 3.0 of this ROD.

On 02 January 2009, AFCEE published notifications of the public information meeting, public comment period, and the public hearing for the CS-10 PP in the *Falmouth* and *Mashpee Enterprises,* and in the *Cape Cod Times.* On 30 January 2009, AFCEE published notifications of the public comment period and the public hearing in the same newspapers. AFCEE also circulated news releases for the public comment period and public hearing on 27 January 2009. The PP was made available for public review at the main public libraries in Bourne, Falmouth, and Sandwich, Massachusetts; the State Library of Massachusetts; the Wilkens Library at Cape Cod Community College; and on the MMR website.

After the ROD is signed, a published notice of the availability of the ROD will be made in the *Cape Cod Times* and the ROD will be available for public inspection and copying at the IRP office.

2.4 SCOPE AND ROLE OF OPERABLE UNIT (OU)

The CS-10 site was organized into separate OUs, focusing on source area and groundwater. The source areas have been investigated and remediated, where necessary; refer to Section 2.2. Soils in non-source areas are not impacted by groundwater contamination and there is no reason to believe that off base soil has been contaminated

by base related activities. This ROD addresses the groundwater OU; and therefore, only the contamination in the groundwater is considered.

The CS-10 plume is located within the south-central portion of the MMR where, through the IRP, AFCEE is responsible for the cleanup of contamination from past military practices.

2.5 SITE CHARACTERISTICS

As described in Section 2.2, environmental data have been collected from the CS-10 area since 1985. The following overview of site characteristics will focus on the current site conditions.

The CS-10 plume is primarily located within the Mashpee Pitted Plain (MPP) (Figure 2-1). The MPP is a broad, flat, gently southward-sloping glacial outwash plain. The MPP consists of stratified outwash sand underlain by silty glaciolacustrine sediment. The topography of the MPP gradually slopes from 140 feet mean sea level (ft msl) in the north to 70 ft msl in the south and is pocked with numerous kettle ponds. Beneath these sediments, a variable thickness of glacial till overlies the bedrock.

The single groundwater flow system that underlies western Cape Cod, including the MMR, is known as the Sagamore Lens. This sole-source aquifer is primarily unconfined and recharged by infiltration of precipitation. Groundwater flow is generally radial from the recharge area toward the ocean, which forms the lateral boundary of the aquifer on three sides; the Bass River in Yarmouth forms the eastern boundary of the Sagamore Lens. Flow direction within the aquifer is generally horizontal with stronger vertical gradients near surface water bodies. Ponds are generally an expression of the water table and are hydraulically connected with the aquifer. The shallow groundwater upgradient of the pond enters the upgradient portion of the pond, flows through the pond, and exits on the downgradient portion of the pond. The deep groundwater upgradient of the pond usually does not discharge to the pond, but rather underflows the pond. Water table elevations fluctuate from 1 to 4 feet per year. The elevation of the water table is

approximately 65 ft msl near the source area and 40 ft msl in the downgradient portion of the plume. The aquifer thickness varies from 260 to 330 feet in the CS-10 area depending on the elevation of the bedrock surface, which forms the bottom of the aquifer.

2.5.1 Conceptual Site Model

The CS-10 plume encompasses several known and suspected contaminant source areas that contributed to groundwater contamination. The primary source area is UTES/BOMARC (Figure 2-2). Numerous other sources of contamination are presumed to have contributed to the CS-10 plume as it migrated downgradient. The contamination from the source mixed with groundwater at the water table and was transported to the south by groundwater flow. The area around the CS-10 plume on-base consists primarily of areas used for military operations. The area south of the base is characterized by undeveloped woodlands and wetlands used for recreation and conservation, and residential areas.

The geology and hydrogeology have been described in several previous reports (AFCEE 2005a, 2008b). The CS-10 plume is located within a late Quaternary geologic feature known as the MPP. The aquifer matrix is primarily composed of unconsolidated fine- to coarse-grained sands with some discontinuous and some fairly continuous fine-grained zones, which collectively compose the sole source aquifer known as the Sagamore Lens. The Sagamore Lens and MPP overlay crystalline bedrock. The total thickness of unconsolidated deposits ranges from 230 to 350 feet. The aquifer thickness varies from 230 to 320 feet depending on the elevation of the bedrock surface. The average groundwater flow velocity is approximately 1 foot/day in the aquifer. Groundwater flow is generally radial from the center of western Cape Cod.

The characteristics of the CS-10 plume have been described in several previous reports (AFCEE 2005a, 2008b). The CS-10 plume contaminants are dissolved in the groundwater and are transported downgradient with groundwater flow. The primary attenuation process for the CS-10 plume is dispersion. The contaminants are migrating through the aquifer with little retardation or volatilization. Most of the plume is captured

by the CS-10 In-plume extraction wells or migrates to the CS-10 Sandwich Road extraction well fence and is captured there. A small portion of the plume is captured by the CS-10 NL remedial system. Small portions of the plume not captured by the remedial systems continue to migrate and attenuate via dispersion (Figure 2-2).

The CS-10 plume is defined by TCE and PCE concentrations (plume COCs) greater than the maximum contaminant level (MCL) [5 micrograms per liter (µg/L) for TCE and PCE]. For plume management purposes, the CS-10 groundwater plume is conceptually divided into two contiguous geographic areas. The portion of the plume located upgradient of Sandwich Road is designated as the main body (Figure 2-2). The portion downgradient of Sandwich Road is designated as the leading edge and is comprised of three lobes: the NL, the NCL, and the SL (Figure 2-2).

Due to the numerous source areas and diverging flow patterns, the distribution of contaminant mass within the CS-10 plume is heterogeneous. The radial flow pattern from the top of the mound of the Sagamore Lens (located just north of the primary CS-10 source area) contributes to the diverging flow patterns in the main body. The western portion of the main body flows in a southwesterly direction while the eastern portion of the main body flows in a southeasterly direction towards Ashumet Pond. The eastern side of the downgradient portion of the main body is influenced by the strong hydraulic gradients influenced by Ashumet and Johns Ponds and flows more southeasterly than the upgradient portion of the main body. The highest monitoring well concentrations of TCE and PCE, located in the main body, decreased from 9,900 µg/L (1989) and 29,000 µg/L (1989) to 1,300 µg/L and 159 µg/L, respectively, in 2008. The upgradient extent of the main body is shallow (–20 to –80 ft msl) and gradually thickens towards the middle of the plume (10 to –80 ft msl) and deepens toward Sandwich Road (–80 to -160 ft msl). Within the past four years, a new area of contamination that is part of the main body of the plume (downgradient of 03EW2111 and the Southern Infiltration Trench, Figure 2-2) has been the subject of recent investigations. Discrete zones of TCE contamination have been delineated at varying elevations south and southeast of the Southern Infiltration Trench. The shallow zone of

contamination is continuous and the most extensive; approximately 2,100 feet wide and up to 50 feet thick (-50 to -105 ft msl) at the base boundary. Recent (2008) maximum TCE concentration in the shallow zone, from monitoring well sampling, is 72 µg/L and the deep contamination is 11.6 µg/L. Throughout most of the plume TCE is more prevalent and at higher concentrations than PCE. The operation of the CS-10 Sandwich Road extraction wells has detached the CS-10 leading edge lobes from the main body.

The most upgradient portion of the CS-10 NL is approximately 550 feet downgradient of the Sandwich Road extraction fence and is approximately 660 feet wide in this area. The NL is strongly influenced by hydraulic gradients caused by Ashumet and Johns Ponds, and flows to the east-southeast. The highest concentrations of TCE and PCE, located in the Horseshoe Bend area, decreased from 1,500 µg/L (2001) and 17 µg/L (2001) to 11.6 µg/L and below the reporting limit, respectively, in 2008, due to operation of the CS-10 Sandwich Road extraction wells. The NL currently underflows Ashumet Pond. Although the data indicate that a portion of the CS-10 plume discharges into Ashumet Pond, surface water samples collected during the RI from within the pond did not contain measurable concentrations of plume constituents. Most of the NL underflows Ashumet Pond and is approximately 3,800 feet long and narrows to between 75 and 100 feet wide at Hooppole Road between Ashumet and Johns Ponds. The maximum 2008 TCE and PCE concentrations in the NL were 304 µg/L and below the reporting limit, respectively. Between the ponds, the NL is much shallower: 15 to -100 ft msl. Due to the operation of the NL extraction well the NL is no longer discharging to Johns Pond.

The NCL also flows in an east-southeast direction due to the influence of Ashumet and Johns Ponds. The maximum 2008 TCE and PCE concentrations in the NCL were 38.1 and 4.2 µg/L, respectively. The NCL is approximately 3,700 feet long and varies in width with a maximum width of approximately 700 feet. There is some uncertainty in the current understanding of the upgradient extent of the NCL as the most recent data in the NCL under Ashumet Pond was collected as part of the extensive 1999 on-pond drilling program. The 1999 drilling program identified areas of clean groundwater on the north and south sides of the NCL that are predicted to remain clean with time; however,

current concentrations within the NCL under Ashumet Pond are estimated from older data. There is also some uncertainty in the downgradient extent of the NCL because an on-pond drilling program has not been conducted for the portion of the NCL under Johns Pond. Based on the historic data (encompassing more than 10 years) from land based drilling and monitoring well sampling results, it is anticipated that the NCL has not migrated significantly under Johns Pond. The uncertainties in the NCL nature and extent were evaluated in CS-10 FS addendum (AFCEE 2007a) through analysis of FS alternatives using a NCL sensitivity plume shell that was more than twice the mass, had twice the maximum concentration and slightly under twice the volume predicted for the NCL.

The NCL is deeper than the NL, and the elevation of the NCL varies from –50 to -100 ft msl in the northern part to –100 to –200 ft msl in the southern part of the lobe. As the NCL migrates downgradient it is predicted to underflow Johns Pond and remain deep in the aquifer (-150 to -200 ft msl). The concentrations in the NCL are predicted to decrease below the MCL beneath Johns Pond. There is some uncertainty in the lateral trajectory of the NCL beneath Johns Pond but there are no indications that the NCL will upwell or be drawn shallower in the aquifer beneath Johns Pond. Also, hydraulic data from east of Johns Pond does not show upward groundwater flow.

The SL is less influenced by the ponds and flows in a southeast direction. The SL is approximately 1,600 feet long and 400 feet wide. There is some uncertainty in the upgradient extent of the SL and the amount of mass in the upgradient portion of the SL based on the limited data available in the SL under Ashumet Pond. The maximum 2008 TCE and PCE concentrations in the SL were 45.6 and 16.2 µg/L, respectively. The SL is deeper in the aquifer (-220 to -240 ft msl) than the NL and NCL. The SL is close to the bottom of the aquifer and has migrated only a small distance downgradient (approximately 400 feet) from when it was identified in the RI.

Previously, a CS-10 plume lobe designated the South Central lobe was defined south of the NCL. Based on analytical data collected as part of the CS-10 Leading Edge

investigation (AFCEE 2005a), the South Central lobe is no longer considered to be present. Also previously in 2005, the Eastern Lobe (EL) was located on the east side of Johns Pond. Based on analytical data collected as part of the SPEIM program, the EL was short lived and no longer exists.

2.5.2 Sampling Strategy

Groundwater samples have been collected in the CS-10 plume area at prescribed frequencies (maximum quarterly frequency) as part of the SPEIM program, which was initiated before the operation of the CS-10 Sandwich Road ETR system in 1999. Hundreds of monitoring wells have been installed in support of monitoring the CS-10 plume and thousands of groundwater samples have been collected. Surface water and sediment samples were collected in the CS-10 plume area as part of investigative and SPEIM activities. The sampling program was initiated as part of the interim remedy for CS-10 groundwater and, thus, is ongoing, and has been revised over the years based on changing conditions (AFCEE 2009a).

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

This section discusses the current and reasonably anticipated future land uses and current and potential beneficial groundwater uses in the vicinity of CS-10 contaminated groundwater, and presents the basis for future groundwater use assumptions.

2.6.1 Land Use

On-base, the CS-10 contaminated groundwater is, primarily overlain by grassy, forested areas used by various tenants of the MMR (Figure 2-3). The off-base area south of the MMR boundary in the CS-10 area is primarily water and residential. Between Ashumet and Johns Ponds, and just south of the MMR boundary, there is some conservation land. Due to the paucity of undeveloped residential lots, it is anticipated that the density of residential development south of the base boundary will not significantly increase over time. It is anticipated that the land use in the CS-10 area will not significantly change over time.

2.6.2 Water Resource Use

There are currently no residential or water supply wells in the CS-10 plume on-base and all of the off-base residences located above the CS-10 plume are believed to be connected to the municipal water supply. The aquifer in this area and throughout the upper Cape Cod, known as the Sagamore Lens, is generally a highly transmissive and productive aquifer, and designated by the MassDEP and EPA as a sole source aquifer (defined as the sole or principal source of drinking water for a given area).

Surface water bodies in the vicinity of the CS-10 plume (Ashumet Pond and Johns Pond) are fed by groundwater and provide recreational use such as fishing, swimming, and boating.

AFCEE has developed a working relationship with the water commissioners of the four towns that surround MMR to ensure that future development of the groundwater resource is coordinated with groundwater monitoring and remediation at the MMR. It is expected that CS-10 related TCE and PCE concentrations will be below the MCL in approximately 90 years.

2.7 SUMMARY OF SITE RISKS

Two risk assessments have been conducted for the CS-10 plume; the preliminary risk assessment (PRA) for the main body of the plume was submitted in 1996 (CDM 1996), and the risk assessment for the leading edge of the plume was submitted in 2001 (AFCEE 2001b). The CS-10 risk assessments evaluated potential for adverse effects from exposure to site contaminants to human and ecological receptors.

Subsequent to the final submittal of the leading edge risk assessment the format for the risk assessment results was revised to adopt the Risk Assessment Guidance for Superfund Part D (RAGs D) format in 2001 (AFCEE 2001a). The results of the 1996 main body risk assessment have not been submitted in RAGs D format. Comments received from EPA on the 2001 RAGs D formatted tables were received in 2004 and addressed updates to methods, exposure parameters, and toxicity values.

This section summarizes the results of the 1996 and 2001 risk assessments and discusses the changes in risk assessment methods, exposure parameters, and toxicity values that have been adopted since the submittal of the risk assessments. The section qualitatively addresses impacts to the risk assessment results resulting from changes in methods, exposure parameters, and toxicity values. Final remediation goals for the CS-10 plume have been developed in accordance with current guidance and toxicity values for the COCs identified for the plume (PCE and TCE).

2.7.1 1996 Preliminary Human Health Risk Assessment Summary (Main Plume Body)

A complete description of the methods and results of the 1996 preliminary human health risk assessment for the CS-10 plume are presented in *Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10 Groundwater Operable Unit: CS-10D and Hydrogeologic Region II Study* (CDM 1996). The PRA for the main plume body evaluated potential adverse human health risks from groundwater contamination using data from monitoring wells and irrigation Well B. The golf course irrigation well, Well B, was evaluated as part of the risk assessment because it was impacted by groundwater contamination at the time the 1996 risk assessment was performed. Well B is currently not located within the CS-10 plume and is not impacted by the CS-10 plume. Exposure point concentrations (EPC) were evaluated separately for current and future risk scenarios using maximum and average concentrations.

Current potential exposures to groundwater were evaluated for dermal contact and inhalation of volatile organics. Future potential exposures to groundwater were evaluated for ingestion, dermal contact, and inhalation of volatile organics. The following exposure scenarios were evaluated:

Current Base Personnel – Base personnel (maintenance workers and golfers) and trespassers could come into contact with contaminated groundwater through inhalation and dermal contact from Well B, which is used for golf course irrigation only. No other potential current on-base exposures exist.

Future Base Personnel – Future base personnel (maintenance workers and golfers) and trespassers could come into contact with contaminated groundwater through inhalation and dermal contact from Well B. Workers other than those exposed to irrigation water, may come into contact with contaminated groundwater through ingestion, inhalation, and dermal contact.

Future Nearby Residents – In the absence of remediation, the existing groundwater plumes may migrate to areas not currently impacted. These nearby residents may be exposed to contaminated groundwater through ingestion, inhalation, and dermal contact.

Future On-Base Residents – The potential exists for residential development outside the security zone. Additional wells may also be needed in the future for an on-base water supply. Future on-base residents may be exposed to contaminated groundwater through ingestion, inhalation, and dermal contact.

Although inhalation was considered for maintenance workers, golfers, and trespassers exposed to irrigation water from Well B, it was not quantitatively evaluated, because it was not likely that these receptors would use water from the irrigation well as a source for showering or drinking. The inhalation risks for these receptors was considered to be much less than for the future resident and worker because residential exposures are assumed to occur in a confined area whereas the maintenance worker, golfer, and trespasser exposures would occur out doors in the open air.

For this risk assessment, EPCs were evaluated separately for current and future risk scenarios for exposure to contaminants in and potentially reaching Well B. Since there were no current receptors for CS-10 groundwater for the monitoring well data originating from the CS-10 source, only future risk scenarios were evaluated. For organic contaminants, mean and maximum concentrations for monitoring wells with contaminants that could be linked to CS-10 source and which define the CS-10 contaminant plume were evaluated. For inorganic contaminants, data from all monitoring wells were evaluated. Since there was potential for contaminated groundwater associated with CS-10 to discharge in the future to Ashumet Pond and other

downgradient surface waters, such as the Coonamessett River or Vineyard Sound, a qualitative evaluation of future potential risks from surface water to human receptors was conducted.

Toxicity values used in the risk assessment were reference doses (RfD) for noncarcinogenic effects and cancer slope factors (SF) for carcinogenic effects obtained from EPA's Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST). EPA's Environmental Criteria Assessment Office was contacted for toxicity values for 1,2-dichloroethene; dibromochloromethane; styrene; m/p-xylene; o-xylene; and iron.

Cancer risk estimates and noncancer hazard index (HI) estimates are summarized in the following paragraphs.

Adult Resident – Future Use – Cancer risk estimates for the adult resident receptor were 1.98E-03 and 3.23E-04 for the maximum and average concentrations, respectively. The primary contributors to the cancer risk estimates based on maximum concentrations were trichloroethylene (TCE) and beryllium.

HI estimates for the adult resident receptor were 69.6 and 10.3 for the maximum and average concentrations, respectively. The primary contributors to the HI based on maximum concentrations were TCE, PCE, aluminum, antimony, arsenic, cadmium, chromium, iron, manganese, and vanadium.

Worker – Future Use – Cancer risk estimates for the worker receptor were 3.00E-04 and 4.66E-05 for the maximum and average concentrations, respectively. The primary contributors to the cancer risk estimates based on maximum concentrations were TCE and beryllium.

HI estimates for the worker receptor were 24.6 and 3.68 for the maximum and average concentrations, respectively. The primary contributors to the HI based on maximum concentrations were TCE, aluminum, antimony, cadmium, iron, and manganese.

Irrigation Well – Current Use – Cancer risk estimates for the trespasser, golfer, and worker receptors were not calculated because dermal toxicity values were not available for PCE.

HI estimates for the trespasser, golfer, and worker receptors were 0.0000536, 0.000146, and 0.0000807, respectively. The primary contributor to the HI was PCE.

Irrigation Well – Future Use – Cancer risk estimates for the trespasser, golfer, and worker receptors were 1.22E-06, 8.27E-06, and 4.57E-06, respectively. TCE was the primary contributor to the cancer risks.

HI estimates for the trespasser, golfer, and worker receptors were 0.102, 0.278, and 0.154, respectively. The primary contributor to the HI estimates was TCE.

2.7.2 2001 Human Health Risk Assessment Summary (Leading Edge Plume)

A complete description of the methods and results of the baseline human health risk assessments for the CS-10 plume are presented in the *Final Chemical Spill-10 Remedial Investigation Report* (AFCEE 2001b). The 2001 risk assessment evaluated potential risk from exposure to groundwater, surface water, and sediment, collected from areas that were not previously defined or evaluated in prior assessments. Two land use scenarios were evaluated: residential ingestion of groundwater and recreational uses of Ashumet and Johns Ponds. At the time of the 2001 risk assessment, the NL was referred to as the TCE plume and that terminology is retained throughout this section and the associated tables.

The 2001 risk assessment was based on data collected from locations sampled between April 1999 and October 2000. Historical data collected prior to April 1999 were not included in the data set for the risk assessment, unless post-April 1999 data were missing for certain locations.

2.7.2.1 Identification of Chemicals of Potential Concern (COPC)

The selection of chemicals of potential concern (COPC) for inclusion in the quantitative human health risk calculations were based on three screening criteria:

- Frequency of detection,
- Compound concentration and toxicity, as compared to conservative risk and/or hazard-based concentrations, and
- Essential nutrient status.

The concentration-toxicity screen was conducted by comparing site data with a series of federal and Massachusetts risk-based criteria current at the time of the assessments. The maximum detected concentration was used in the concentration-toxicity screen.

For groundwater, the following screening criteria were used for the 2001 risk assessment:

- EPA Region IX preliminary remediation goals (PRG) for residential tap water (EPA 2000a),
- EPA MCLs (EPA 2000c), and
- Massachusetts drinking water standards and guidelines (MassDEP 2000).

For surface water, the same groundwater screening criteria were used with the addition of the EPA recommended water quality criteria for human health consumption of water and organisms (EPA 1999b). For sediment, the EPA Region IX PRGs for residential soil (EPA 2000a) were used.

PRGs for noncarcinogens were modified such that the PRG was based on a noncancer hazard quotient (HQ) of 0.1. PRGs for carcinogens are based on a cancer risk level of 1E-06. When more than one criterion was available for a compound, the lowest of the criteria was used in the concentration-toxicity screen.

Groundwater in the CS-10 risk assessment was evaluated separately in subsets, based on the influence of the existing remedial system and different exposure time frames:

groundwater within the TCE plume, current groundwater outside the TCE plume, and future groundwater outside the TCE plume. The current groundwater outside the TCE plume included groundwater data from location drilled on land. The future groundwater outside the TCE plume included groundwater data collected from locations drilled on land and groundwater collected from beneath Ashumet and Johns ponds. Surface water and sediment in Ashumet and Johns ponds were also evaluated. The tables presenting the screening process for identifying COPCs in each area are listed below:

- Groundwater within the TCE plume (Table 2-1),
- Current Leading Edge Groundwater outside the TCE plume (Table 2-2),
- Future Leading Edge Groundwater outside the TCE plume (Table 2-3),
- Ashumet and Johns Pond Surface Water (Table 2-4), and
- Ashumet and Johns Pond Sediment (Table 2-5).

Table 2-1, Table 2-2, Table 2-3, Table 2-4, and Table 2-5 present the occurrence and distribution of compounds detected in the CS-10 areas listed above. For each detected chemical, these tables include the minimum and maximum detected concentration, the data qualifiers associated with these concentrations, the location of the maximum detected concentration, the frequency of detection, and the range of detection limits. The "J" qualifier indicates estimated concentrations.

2.7.2.2 Exposure Assessment

The assessment evaluated potential risk to receptors from exposure to surface water and sediment in the ponds as well as exposure to current and future groundwater conditions. No off-base residents are believed to be exposed to the CS-10 plume (all off-based residents overlying the CS-10 plume are believed to be connected to the public water supply), but potential current risk was evaluated. Three separate exposure areas were delineated for potential groundwater exposure. The TCE plume, which is one component of the CS-10 plume, was identified as one exposure area, because it is already undergoing remediation and is a segregable portion of the plume. Everything outside the TCE plume but within the CS-10 RI study area was considered the second exposure area and a

current use scenario (Current CS-10 Leading Edge Groundwater). The third exposure area included groundwater outside the TCE plume and underneath the ponds, and was considered a future use scenario (Future CS-10 Leading Edge Groundwater).

The human health conceptual exposure model for the CS-10 site is illustrated in Figure 2-4. The resident receptor, comprised of a young child age group and an adult age group, was quantitatively evaluated in the current and future use exposure scenarios for the following potential exposure pathways:

- Ingestion of groundwater as drinking water, and
- Incidental ingestion of and dermal contact with chemicals in surface water and sediment while swimming or wading in Ashumet and Johns Ponds.

Inhalation of and dermal contact with volatile organic compounds (VOC) (e.g., TCE, PCE, etc.) during household use of groundwater (e.g., bathing, showering) was evaluated qualitatively, in accordance with EPA guidance (EPA 1995). Inhalation of VOCs in surface water while swimming was not evaluated in the risk assessment, because the levels of VOCs in surface water were very low (less than 5 μg/L).

While people could also fish in Ashumet and Johns Ponds, fishing is unlikely to be a significant exposure route because of the non-bioaccumulative nature of TCE, PCE, ethylene dibromide (EDB), and other chlorinated organic compounds detected in groundwater. Therefore, the fishing pathway was not evaluated in the risk assessment.

For groundwater, the EPCs for the reasonable maximum exposure (RME) condition were the maximum concentrations. The measurement data for the two ponds were combined for the purposes of determining the EPCs for surface water and sediment exposure. The lower of the 95 percent UCL or the maximum detected concentration of each COPC in surface water is used to estimate the EPC for the RME scenario. The EPCs for each area and media are presented in the tables listed below:

- Medium-Specific Exposure Point Concentrations Summary, TCE Plume (Table 2-6);
- Medium-Specific Exposure Point Concentrations Summary, Current CS-10 Leading Edge Groundwater (Table 2-7);

- Medium-Specific Exposure Point Concentrations Summary, Future CS-10 Leading Edge Groundwater (Table 2-8);
- Medium-Specific Exposure Point Concentrations Summary, Ashumet and Johns Pond Surface Water (Table 2-9); and
- Medium-Specific Exposure Point Concentrations Summary, Ashumet and Johns Pond Sediment (Table 2-10).

To quantitatively assess the potential carcinogenic risks and health hazards, daily intakes of the COPCs were calculated based on receptor-specific, site-specific, and chemical-specific exposure parameters. These exposure parameters may vary depending on the time frame, exposure medium, exposure point, and receptor population and age. Exposure assumptions and other parameters used in the chronic daily intake (CDI) or dermal absorbed dose (DAD) algorithms are presented for each receptor and exposure medium in the tables listed below:

- Values Used for Daily Intake Calculations, Adult - Groundwater (Table 2-11);
- Values Used for Daily Intake Calculations, Adult - Surface Water (Table 2-12);
- Values Used for Daily Intake Calculations, Adult - Sediment (Table 2-13);
- Values Used for Daily Intake Calculations, Child – Groundwater (Table 2-14);
- Values Used for Daily Intake Calculations, Child – Surface Water (Table 2-15); and
- Values Used for Daily Intake Calculations, Child – Sediment (Table 2-16).

2.7.2.3 Toxicity Assessment

At the time of the risk assessment was prepared, toxicity values were obtained from EPA's most current versions of IRIS or the HEAST, which are databases containing toxicity values for use in quantitative risk assessment. Cancer and non-cancer toxicity factors for each of the COPCs evaluated in the risk assessments for CS-10 are presented in the tables listed below:

- Non-Cancer Chronic Toxicity Data – Oral/Dermal (Table 2-17), and
- Cancer Toxicity Data – Oral/Dermal (Table 2-18).

2.7.2.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk (ELCR) is calculated from the following equation:

Risk = (CDI or DAD) x SF

Where

Risk = a unitless probability of an individual developing cancer
CDI = chronic daily intake [milligrams per kilogram per day (mg/kg-day)]
DAD = dermal absorbed dose (mg/kg-day)
SF = slope factor $(mg/kg\text{-}day)^{-1}$

Carcinogenic risks are probabilities that usually are expressed in scientific notation (e.g., 1E-06). An ELCR of 1E-06 indicates that an individual experiencing the RME theoretically has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an ELCR because it would be in addition to the risk of cancer an individual faces from other causes such as exposure to too much solar radiation or radon. In accordance with the NCP, ELCR estimates at CS-10 are compared to EPA's target risk range for site-related exposures of 1E-04 to 1E-06 (EPA 1991b). For informational purposes, under the Massachusetts Contingency Plan [310 Code of Massachusetts Regulations (CMR) 40], sites where the risk is less than 1E-05 (one in 100,000) are considered to have attained a level of no significant risk.

Separate assumptions were used to calculate doses for adult and child residents, and then cancer risks for the adult and child were combined to represent total risks to off-site residents for a 30-year exposure period.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with an RfD derived for a similar exposure period. An RfD represents a level to which an individual may be exposed that is not expected to cause any deleterious effect. The ratio of exposure to toxicity, which is called a HQ, is calculated as follows:

Non-cancer HQ= (CDI or DAD)/(RfD)

Where

CDI = chronic daily intake (mg/kg-day)

DAD = dermal absorbed dose (mg/kg-day)

RfD = reference dose (mg/kg-day)

The HI is calculated by adding the HQs for all COCs that affect the same target organ (e.g., prostate) within a medium or across all media to which a given individual may reasonably be exposed. An HI less than one indicates that, based on all of the different contaminants and exposure routes, toxic noncarcinogenic effects are unlikely. An HI greater than one indicates that site-related exposures may present a hazard to human health.

The tables listed below are the tables from the risk assessments that summarize the cancer and non-cancer risks to each receptor under the RME exposure scenario. Cancer and non-cancer risks that appear in these tables are limited to those for the COPCs that produced cancer or non-cancer risks at or near regulatory thresholds. Risks associated with COPCs that produced ELCRs less than 1E-06 or HQs less than 0.1 do not appear in these tables (EPA 1991b).

- Risk Assessment Summary, Reasonable Maximum Exposure, TCE Plume, Current, Adult (Table 2-19);
- Risk Assessment Summary, Reasonable Maximum Exposure, TCE Plume, Current, Child (Table 2-20);
- Risk Assessment Summary, Reasonable Maximum Exposure, Leading Edge Groundwater, Current, Adult (Table 2-21);
- Risk Assessment Summary, Reasonable Maximum Exposure, Leading Edge Groundwater, Current, Child (Table 2-22);
- Risk Assessment Summary, Reasonable Maximum Exposure, Leading Edge Groundwater, Future, Adult (Table 2-23); and
- Risk Assessment Summary, Reasonable Maximum Exposure, Leading Edge Groundwater, Future, Child (Table 2-24).

The RME ELCR estimates were 4.3E-04, 3.2E-04, and 3.4E-04 for residents in the TCE Plume, Current Leading Edge Groundwater, and Future Leading Edge Groundwater

exposure areas, respectively. The HI estimates for the adult resident were 13.7, 7.7, and 8.5 for the TCE Plume, Current Leading Edge Groundwater, and Future Leading Edge Groundwater exposure scenarios, respectively. The RME HI estimates for the child resident were 33.3, 18.9, and 20.9 for the TCE Plume, Current Leading Edge Groundwater, and Future Leading Edge Groundwater exposure scenarios, respectively. The predicted ELCR and HI estimates for the resident receptor under the RME scenario exceed the EPA and MassDEP risk management benchmarks for both current and future drinking water. Most of the cancer and noncancer risk is due to TCE, and to a lesser extent EDB and PCE, in drinking water within the TCE plume as well as outside of the TCE plume. Outside the TCE plume, arsenic and manganese also contribute significantly to total site risk. Risks from surface water and sediment in Ashumet and Johns Ponds are slightly above 1E-06 and an HI of 1.0. These risks are due to bis(2-ethylhexyl) phthalate (BEHP) (attributed to sampling contamination), manganese in surface water (attributed to non-CS-10 sources), and arsenic in sediment (attributed to background).

2.7.2.5 Uncertainty Analysis and Human Health Risk Assessment Conclusions

There are uncertainties involved in the process of quantifying the risk for human receptors, and overall they make the risk assessment very conservative. Exposure assumptions, SFs, and oral-to-dermal adjustment factors are all very conservative. Some of the assumptions have a firm scientific basis, while others do not. Some level of uncertainty is introduced into the risk characterization process every time an assumption is made. In regulatory risk assessment, the methodology dictates that assumptions err on the side of overestimating potential exposure and toxicity. The effect of using numerous assumptions that each overestimate potential exposure and toxicity is to exaggerate estimates of potential human risk. Such estimates may be useful for regulatory decision making, but do not provide a realistic estimate of potential health impacts. The RME exposure scenario evaluated in this risk assessment uses many upper-bound conservative assumptions.

The results of this baseline risk assessment indicate that potential risks using RME assumptions are above the acceptable risk benchmarks used in regulatory agency

decision-making. Total cancer risks for the resident receptor are above the upper end of the EPA acceptable risk range of 1E-04 and the MassDEP target risk of 1E-05 for the TCE plume, current drinking water, and future drinking water. Total noncancer HIs for both the adult and child are above the EPA and MassDEP target HI of 1.0 for all three groundwater exposure areas, even after performing a target-organ-specific analysis.

Most of the unacceptable risk is due to TCE in drinking water, with significant contributions also from manganese, arsenic, EDB, and to a lesser extent, PCE in drinking water. As previously noted, concentrations of arsenic and manganese in groundwater are below background levels and are not related to the CS-10 plume. Risks from surface water and sediment in Ashumet and Johns Ponds are attributed to sampling contamination, non-CS-10 sources, and background.

2.7.3 Summary of the CS-10 Ecological Risk Assessments (ERA)

Prior to completion of the 2001 risk assessment for the leading edge of the CS-10 groundwater plume, two previous screening level risk assessments had been performed:

- A PRA was previously conducted for the AOC CS-10D groundwater OU (CDM 1996). This PRA was conducted in accordance with the procedures contained in the *Final Risk Assessment Handbook* (ASG 1994) for evaluation of potential human health and ecological risks at MMR, and contained many highly conservative assumptions. The 1996 CS-10 PRA concluded that potential risks to aquatic and vertebrate wildlife ecological receptors may exist from exposure to numerous compounds in the CS-10 groundwater plume, including TCE, di-n-butylphthalate, BEHP, dieldrin, aluminum, antimony, cadmium, cobalt, copper, manganese, mercury, thallium, vanadium, and zinc.
- A screening level ecological risk characterization was previously presented for the NL, know as the TCE plume at the time of the risk assessment, a plume that discharges to Johns Pond (AFCEE 1999a). This risk assessment, which was conducted with a number of conservative assumptions, concluded that: (1) there were no significant ecological risks to ecological receptors in the water column in Johns Pond above the area of the TCE plume groundwater upwelling; and (2) the maximum concentration of TCE in groundwater exceeded its surface water benchmark for aquatic organisms. Based on this conservative evaluation, it was concluded that there might be adverse impacts from exposure of benthic invertebrates and bottom-dwelling fish to TCE in the immediate area near the sediments where groundwater discharges to Johns Pond.

Based on these earlier screening level ecological risk assessments (ERA), a conclusion of no significant risk could not be reached for ecological receptors potentially exposed to sediment and surface water in the Johns Pond and Ashumet Pond within the CS-10 RI study area. Therefore, a screening level ERA was prepared to provide a screening level evaluation of potential current and future ecological risk associated with exposure to environmental media in these two lacustrine bodies of water.

The primary objective of the CS-10 ERA was to evaluate whether or not populations of ecological receptors were potentially at risk from exposure to chemical stressors in surficial media (i.e., sediment and surface water) in Johns Pond and Ashumet Ponds, located within the CS-10 RI study area. These two ponds have the potential to contain chemical stressors from discharge of the CS-10 groundwater plume to the surface. Both current and potential future ecological risks were evaluated in this screening level ERA.

The Tier I ERA was conducted according to relevant state and federal guidance, including the following:

- Intermittent *ECO Update* Bulletins of EPA (published between documents 1991a and 1996),
- *Tri-Services Procedural Guidelines for Ecological Risk Assessments*; Volume I (Wentsel et al. 1996),
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (Interim Final) (EPA 1997),
- Guidelines for Ecological Risk Assessment (EPA 1998), and
- Guidance for Disposal Site Risk Characterization Under the MCP, Environmental Risk Characterization Interim Final Policy, 22 April 1996 (MassDEP 1996).

The principal components of the Tier I ERA include:

Problem Formulation: In this step, the objectives of the ERA were defined, and a plan for characterizing and analyzing risks was determined. Available information regarding stressors and the specific site was integrated. Products generated through problem

formulation included measurement and assessment endpoints and the conceptual exposure model (Figure 2-5).

Risk Analysis: Risk analysis was directed by the problem formulation. Data were evaluated to characterize potential ecological exposures and effects.

Risk Characterization: During risk characterization, exposure and stressor response profiles were integrated through risk estimation.

The following ecological receptor groups were evaluated in the screening-level ERA:

- Vertebrate wildlife (e.g., piscivorous mammals and birds such as raccoon, mink, green-backed heron, and osprey);
- Aquatic vertebrates (e.g., fish);
- Aquatic plants (e.g., algal and macrophytic vegetation); and
- Aquatic/benthic invertebrates (e.g., benthic macroinvertebrates).

These groups of receptor species were selected because they are: (1) potentially exposed to chemical stressors in surficial media at the site; (2) presumed to play key roles in site ecosystems; (3) have complex life cycles; (4) characterized by rapid larval growth rates (e.g., benthic macroinvertebrates); and (5) representative of the range of trophic levels in food webs and food chains at the CS-10 RI study area.

Potential risks to aquatic organisms such as invertebrates and plants from chemical of potential ecological concern (COPEC) exposure were evaluated based on the results of the following measurement endpoints:

- Comparisons of measured surface water data with literature-derived toxicity thresholds (e.g., water quality criteria and guidelines), and
- Comparisons of measured sediment data with literature-derived toxicity thresholds (e.g., sediment quality screening values).

Potential risks to the representative vertebrate wildlife species associated with ingestion of COPECs were evaluated using the HQ approach [this approach is also referred to as the toxicity quotient method in MassDEP (1996)]. Each HQ was calculated by dividing the potential total dietary exposure concentration (i.e., total daily dose) by the corresponding toxicity reference value (TRV). When the estimated dose was less than the TRV (i.e., the HQ less than one), it was assumed that exposure to a COPEC would not be associated with adverse effects to single receptors (i.e., inhibited growth, reproduction, and survival of the individual organism) or wildlife populations. When the HQ is greater than the TRV (HQ greater than one), there is a potential for adverse effects to a receptor from exposure to the COPEC.

The results of this screening level ERA suggest that certain ecological receptors may potentially be at risk from exposure to COPECs in surface water and sediment in Ashumet Pond and Johns Pond. These COPECs were not related to the CS-10 organic constituent plume since they are generally inorganics, which were not detected above background levels in the CS-10 plume upgradient of Ashumet Pond.

The maximum concentrations for virtually all analytes in both surface water and sediment were obtained from Ashumet Pond. The *Final Ashumet Pond Trophic Health Technical Memorandum* (AFCEE 2002) documented elevated concentrations of inorganic compounds in the hypolimnion of Ashumet Pond relative to Johns Pond, specifically manganese and iron. Contributing factors to the elevated concentrations may include the addition of metals due to the impact of the sewage plume on the aquifer and the possible deterioration of the trophic state of Ashumet Pond as compared to Johns Pond. Other sources of inorganic compounds introduced to Ashumet Pond include septic systems and runoff from abandoned Cranberry Bog 3 and other areas (AFCEE 2002). These inorganic inputs are dispersed throughout the pond by storm, wave, and current action. In summary, these COPECs were not believed to be related to the CS-10 plume but rather may be a result of other inputs to the ponds (e.g., the Ashumet Valley plume, sewage plume, and surface runoff from abandoned bog 3 and other areas) combined with the trophic state of Ashumet Pond.

Aquatic receptors (e.g., macrophytic plants, aquatic invertebrates, and fish) in Ashumet and Johns Ponds may be at risk from several inorganic compounds in the water column; these include barium, boron, and manganese. All of these, except manganese, were detected at low concentrations, below background levels. No potential risks are associated with exposure to organic constituents related to the CS-10 plume. This conclusion is based on the following screening level ERA findings:

- Surface water screening values were available for the majority of COPECs. Concentrations of several inorganic COPECs in surface water exceeded chronic surface water screening values. Concentrations of two inorganic constituents (boron and manganese) exceeded acute surface water screening values.
- Concentrations of BEHP in surface water exceeded the chronic screening value used in the risk assessment. BEHP is a common laboratory contaminant and is present in the plastic tubing commonly used in field and laboratory settings. The concentration of BEHP in surface water was below the 1994 secondary chronic value but greater than the 1996 secondary chronic value. EPA has indicated in their National Recommended Water Quality Criteria documentation (EPA 1999b) "there is a full set of aquatic life toxicity data that shows that BEHP is not toxic to aquatic organisms at or below its solubility limit."
- Sediment screening values were available for the majority of COPECs. Several COPECs in sediment exceeded low effect sediment quality screening values. With the exception of acetone, a likely laboratory contaminant, no COPECs were present at concentrations in excess of severe effect sediment quality screening values.
- Background concentrations of COPECs in surface water were generally similar to concentrations in Ashumet and Johns Ponds surface water. Boron, which exceeded both acute and chronic screening values in site water, was greater in background and exceeded screening values. Concentrations of manganese in site water were greater than background concentrations.
- With the exception of manganese and mercury, background concentrations of inorganic COPECs in sediment were greater than or generally consistent with site data. The mercury upper tolerance limit in the background sediment data set exceeded the low effect screening value and was only slightly higher than site concentrations. Unlike manganese in site sediment, the concentration of manganese in the background data set did not exceed sediment screening values.

Little to no significant potential risks to vertebrate wildlife were likely from exposure to COPECs in CS-10 surface water and sediment. This conclusion was based on the following ERA findings:

- Most of the HQs for the species evaluated in the screening level ERA were well below one or were consistent with background HQs, suggesting limited potential for ecological risks associated with surface water or sediment exposure.
- Potential exposure to several inorganic COPECs in surface water and sediment resulted in elevated HQs; these COPECs included aluminum, vanadium, and cadmium (none of which are CS-10 site-related). However, potential exposure to aluminum at background concentrations results in HQs slightly in excess of one and greater than the maximum exposure site HQ. For cadmium and vanadium, the background HQs, although slightly less than one, were greater than site average exposure HQs. The results of this evaluation confirm the conservative nature of the food chain model used in this evaluation, and suggests that use of this model results in an overestimate of potential risks from constituents such as aluminum, vanadium, and cadmium.

2.7.4 Changes in Risk Assessment Practices

Risk assessment methods and exposure parameters have remained relatively constant since EPA first published its *Risk Assessment Guidance for Superfund* (EPA 1989). The most significant change in methods has been in the area of toxicity values, specifically the adoption by EPA Region 1 of the use of Reference Concentrations and unit risk factors for the evaluation of potential noncancer hazards and cancer risks, respectively, associated with the inhalation exposure pathway. Additionally, changes to specific toxicity values have occurred as part of EPA's regular review and update process. Table 2-25 presents the changes in toxicity values since the original risk assessments were prepared and current values. The most significant change is the derivation of cancer SFs for the oral route of exposure for bromodichloromethane; chlordane; chloroform; 1,3-dichloropropene; methyl tert-butyl ether; and PCE. This change would result in an increase in the cancer risk for these constituents. Additionally, numerous cancer and noncancer toxicity values for the inhalation pathway have been derived which would result in an increase in the cancer risk and non-cancer HQs for these constituents.

However, the oral route of exposure is likely to dominate potential exposures to groundwater.

2.8 REMEDIAL ACTION OBJECTIVES (RAO)

Results of the human health and ERA for CS-10 groundwater, along with more recent sampling results, were considered in conjunction with expected current and future use of the aquifer to develop RAOs. There were no risks to human health or ecological receptors due to exposure to surface water and sediment. Therefore, RAOs for CS-10 groundwater only, agreed upon by AFCEE, the EPA, and the MassDEP, were developed to evaluate the alternatives with respect to protecting human health:

- Prevent residential exposure to CS-10 groundwater containing concentrations of TCE or PCE greater than 5 μg/L.
- Return useable groundwaters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site.

The remedial alternatives were developed to satisfy these RAOs. The groundwater cleanup levels as specified in the RAOs are the MCLs for TCE and PCE (5 μg/L).

2.8.1 Basis and Rationale for Remedial Action Objectives (RAO)

For human health concerns, the only media/exposure pathway that presents a cancer risk and/or a non-cancer HI above the target values is the future potential residential exposure to groundwater. A summary of the human health total non-cancer HIs and cancer risks for the CS-10 groundwater area indicates that PCE and TCE increase risk and hazards associated with exposure to groundwater.

2.8.2 Steps to Achieving Remedial Action Objectives (RAO)

MMR groundwater plumes, including the CS-10 plume, are located within the Cape Cod sole-source aquifer. Therefore, AFCEE has agreed that for all active remedies selected, it will undertake a three-step process in achieving RAOs. This three-step process will be implemented in the following manner:

(1) **During the period that treatment systems are remediating the aquifer to federal and state drinking water standards or other risk-based cleanup levels, AFCEE will monitor the plume in accordance with an approved system performance monitoring plan.** The performance monitoring program will collect data for evaluating (a) whether the system is performing as designed, (b) whether the system is impacting ecologically sensitive areas, (c) the potential for short-term health effects due to exposures during active remediation, and (d) when the selected remedy will attain the remediation goals in the ROD.

(2) **In accordance with applicable EPA guidance, a residual risk assessment(s) will be performed to determine if unacceptable ecological and/or human health risks are present, system operation will continue, and/or additional measures will be pursued as required to achieve acceptable risks.** AFCEE shall conduct a residual risk assessment(s), if deemed necessary, of all contaminants remaining in the aquifer associated with the CS-10 plume to determine whether the groundwater contamination continues to pose unacceptable ecological and/or human health risks. This risk determination shall be made jointly by AFCEE, in consultation with the EPA and MassDEP, and may result in aquifer cleanup that is more protective than the NCP point-of-departure risk of 10^{-6} [40 Code of Federal Regulations (CFR) Part 300.430 (e)(2)], if justified, based on the following site-specific factors: cumulative effects of multiple contaminants, the potential for exposure from other pathways of exposure at the site, population, sensitivities, potential impacts on environmental receptors, and cross-media impacts (NCP Preamble, page 8717).

(3) **Once acceptable risk levels have been achieved, the technical and economic feasibility of additional remediation to approach or achieve background concentrations will be evaluated.** AFCEE shall proceed with a technical and economic feasibility analysis of approaching or achieving background concentrations in the aquifer. The feasibility of approaching or achieving background will be determined in accordance with the following criteria:

(a) Technological – Not feasible if

i. the existing technologies or modification cannot remediate to a level of no significant risk, or to levels that approach or achieve background; or

ii. the reliability of the identified alternative has not been sufficiently proven and a substantial uncertainty exists as to whether it will effectively reduce risk; or

iii. the remedy does not or cannot be modified to meet other regulatory requirements.

(b) Economic – The benefits of implementing a remedy and reducing the concentrations of contaminants in the environment to levels that approach or achieve background justifies related costs unless

i. the incremental cost for the remedy is substantial and disproportional to the increased reduction of risk, environmental restoration, and monetary and non-monetary values; or

ii. the risk of harm to health/safety/public welfare/environment by the remedy cannot be adequately controlled.

AFCEE and EPA, with input from MassDEP, have also agreed that in the event that implementation of this process leads to a mutual decision to undertake additional cleanup and such decision results in a significant or fundamental change to the remedial approach, cleanup levels, and/or costs documented in this final ROD, AFCEE will execute an Explanation of Significant Differences or ROD Amendment (with public comment), as appropriate. Whether any such additional cleanup actions result in a significant or fundamental change to this final ROD shall be determined by AFCEE in consultation with MassDEP and the EPA in accordance with the criteria set forth in EPA's *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents* (EPA 1999a). In the event that a dispute arises regarding any of the determinations reached under the process outlined above, such dispute shall be resolved under the dispute resolution procedure of the MMR FFA.

2.9 DESCRIPTION OF CS-10 GROUNDWATER ALTERNATIVES

The CS-10 groundwater FS conducted in 2002 to 2003 (AFCEE 2003b) has been superseded by the more recent CS-10 FS addendum (AFCEE 2007a) and the supplement to the CS-10 FS addendum (AFCEE 2008a). The final alternative evaluation consists of the alternatives presented in the CS-10 FS addendum (AFCEE 2007a) and the supplement to the CS-10 FS addendum (AFCEE 2008a).

The first six alternatives (Alternatives 1 through 6) were developed to address the entire CS-10 plume; the main body and the leading edge. The alternatives were evaluated in the *Final Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2007a). Changes to the ETI/ETR systems in the main body of the plume were not evaluated in the FS addendum.

Four additional alternatives (Alternatives 7 through 10) were developed to evaluate the main body of the plume, specifically the CS-10 groundwater contamination identified south of the Southern Infiltration Trench. The additional alternatives for the main body of the CS-10 plume were developed and evaluated in the *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2008a). The four

alternatives solely addressed the main body of the CS-10 plume. Alternatives 7 through 10 were designed so that the final remedy selected for the entire CS-10 plume would consist of the main body remedy selected from Alternatives 7 through 10 and the leading edge component of the final remedy selected from Alternatives 1 through 6.

The component common to most of the alternatives are LUCs. Several LUCs protect area residents from exposure to CS-10 groundwater contaminants. The safety of all public water supplies within Massachusetts is currently regulated by the Commonwealth. Residents and workers on the MMR receive their water from the base water supply system. All off-base residences located above the CS-10 plume are believed to be connected to municipal water supplies. The off-base LUCs include the towns of Mashpee and Falmouth regulating the use of existing wells and the installation of private wells to reduce potential residential exposure to contaminated groundwater. Implementation of AFCEE LUCs (Section 2.11.2) will prevent any exposure to contaminated groundwater in the CS-10 area through existing wells by confirming residences are connected to municipal supplies or that existing residential wells are not contaminated.

2.9.1 Groundwater Remedial Alternatives

Ten groundwater alternatives were evaluated in two separate feasibility studies.

2.9.1.1 Alternatives 1 through 6

These alternatives were evaluated in the 2007 CS-10 FS addendum (AFCEE 2007a) and address the main body and the leading edge of the CS-10 plume.

Alternative 1 – No Action

The no-action alternative is required by the NCP [40 CFR 300.430(e)(6)] to provide a baseline condition if no remedial action is taken. This no-action alternative would mean that current active remediation (In-Plume, Sandwich Road, and NL remedial systems) would cease when the ROD is signed. Hydraulic and chemical monitoring of the plume

would not continue. AFCEE would not check adherence to LUCs under Alternative 1. Alternative 1 is a baseline scenario that is required to compare Alternatives 1 through 6.

Alternative 2 – Long-Term Monitoring (LTM) with Land Use Controls (LUCs)

Alternative 2 is a limited-action alternative. Remediation via active treatment of the CS-10 plume would cease. This alternative would provide for LTM of groundwater. Continued monitoring and reporting would be implemented to assess the attenuation of the CS-10 plume and determine when COC concentrations have reached cleanup levels. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years throughout the lifetime of the alternative. AFCEE will conduct a residual risk assessment, if deemed necessary, and would likely include additional data collection and analysis.

Alternative 3 – Continue to operate and optimize the existing CS-10 ETR and ETI systems, LTM, and LUCs

Alternative 3 provides for continued active treatment of the CS-10 plume using the existing CS-10 ETR/ETI systems (In-Plume, Sandwich Road, and NL remedial systems) and maintaining the SPEIM program and LUCs (Figure 2-6). The SPEIM program includes chemical and hydraulic monitoring. LTM would be conducted throughout the plume to measure changes in groundwater contamination concentrations. A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

Alternative 4 – Continue to operate and optimize the existing CS-10 ETR and ETI systems, additional extraction in the NCL, LTM, and LUCs

Alternative 4 includes continued O&M and SPEIM of the existing CS-10 ETR/ETI systems (In-Plume, Sandwich Road, and NL remedial systems) with expansion of the system to capture the NCL (Figure 2-6). This system expansion would include the installation of a single extraction well within the NCL, from which water would be processed at the SRTF and returned to the aquifer through existing reinjection wells.

LTM would be conducted throughout the plume to measure changes in groundwater contamination concentrations. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

Alternative 5 – Continue to operate and optimize the existing CS-10 ETR and ETI systems, additional extraction in the NCL and SL, LTM, and LUCs

Alternative 5 includes continued O&M and SPEIM of the existing CS-10 ETR/ETI systems (In-Plume, Sandwich Road, and NL remedial systems) with expansion of the system to capture the NCL and SL (Figure 2-6). This system expansion would include the installation of one extraction well within the NCL and one extraction well within the SL, from which water would be processed at the SRTF and returned to the aquifer through existing reinjection wells. LTM would be conducted throughout the plume to measure changes in groundwater contamination concentrations. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

Alternative 6 – Continue to operate and optimize the existing CS-10 ETR and ETI systems, additional extraction in the NCL, installation of a permeable reactive barrier (PRB) in the SL, LTM, and LUCs

Alternative 6 includes continued O&M and SPEIM of the existing CS-10 ETR/ETI systems (In-Plume, Sandwich Road, and NL remedial systems) with expansion of the system to capture the NCL and in-situ treatment of the SL. This system expansion would include the installation of one extraction well within the NCL and a zero-valent iron permeable reactive barrier (PRB) within the SL along Hooppole Road. Water from the NCL would be processed at the SRTF and returned to the aquifer through existing reinjection wells. LTM would be conducted throughout the plume to measure changes in groundwater contamination concentrations. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years

throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

2.9.1.2 Alternatives 7 through 10

These alternatives were evaluated in the 2008 supplement to the CS-10 FS addendum (AFCEE 2008a) and solely address the main body of the CS-10 plume. The leading edge of the plume is not addressed in these alternatives. Alternatives 1 through 6 address the main body and the leading edge of the plume.

Alternative 7 – No Action for the main body of the plume

The no-action alternative is required by the NCP [40 CFR 300.430(e)(6)] to provide a baseline condition if no remedial action is taken. This no-action alternative would mean that current active remediation (In-Plume and Sandwich Road remedial systems) would cease when the ROD is signed. Hydraulic and chemical monitoring of the plume would not continue. AFCEE would not check adherence to LUCs under Alternative 7. Alternative 7 is a baseline scenario that is required to compare Alternatives 8 through 10.

Alternative 8 – Long-Term Monitoring (LTM) with LUCs for the main body of the plume

Alternative 8 is a limited-action alternative. Remediation via active treatment of the main body of the CS-10 plume (In-Plume and Sandwich Road remedial systems) would cease. This alternative would provide for chemical monitoring of groundwater. Continued monitoring and reporting would be implemented to assess the attenuation of the CS-10 plume and determine when COC concentrations have reached cleanup levels. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years throughout the lifetime of the alternative. AFCEE will conduct a residual risk assessment, if deemed necessary, and would likely include additional data collection and analysis.

Alternative 9 – Continue to operate and optimize the CS-10 In-plume and Sandwich Road ETI/ETR systems, and LTM and LUCs for the main body of the plume

Alternative 9 includes continued O&M and SPEIM of the existing CS-10 ETR/ETI systems for the main body of the plume (In-Plume and Sandwich Road) (Figure 2-7). LTM would be conducted for the main body of the plume to measure changes in groundwater contamination concentrations. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

Alternative 10 – Continue to operate and optimize the CS-10 In-plume and Sandwich Road ETI/ETR systems, system expansion, treatment in the Southern Trench area, and LTM and LUCs for the main body of the plume

Alternative 10 includes continued O&M and SPEIM of the existing CS-10 ETR/ETI systems for the main body of the plume (In-Plume and Sandwich Road) and a new extraction well in the Southern Trench area and a new reinjection well northwest of the southern Sandwich Road reinjection wells (Figure 2-7). The water extracted from the new extraction well would be pumped to the SRTF for treatment and returned to the aquifer through the existing CS-10 and SD-5 reinjection wells. Flow to the new reinjection well will come from the CS-10 In-Plume treatment plant. LTM would be conducted for the main body of the plume to measure changes in groundwater contamination concentrations. LUCs would restrict exposure to contaminated groundwater. A CERCLA review would be performed every five years throughout the lifetime of the alternative. A residual risk assessment would be performed, if necessary, and would likely include additional data collection and analysis.

2.9.2 Common Elements and Distinguishing Features of Alternatives

Ten groundwater alternatives were evaluated as part of the FS addendum and the supplement to the FS addendum: no-action alternatives (Alternatives 1 and 7), limited-action alternatives (Alternatives 2 and 8), and six active treatment alternatives (Alternatives 3, 4, 5, 6, 9, and 10). The six active treatment alternatives include varying

degrees of increased plume remediation in different parts of the plume through the installation of additional extraction wells. All of the alternatives, except the no action alternatives (Alternatives 1 and 7), include LUCs, LTM, CERCLA reporting, and a residual risk assessment, if deemed necessary.

Alternatives 1 and 7 provide no action and would mean that the current treatment systems would shut down, and chemical and hydraulic monitoring would cease. Alternatives 1 and 7 would not include LUCs that limit exposure to the CS-10 plume and would not actively reduce the toxicity, mobility, or volume of the contaminants. The plume would naturally attenuate, but there would be no monitoring to document that it was occurring. Alternatives 2 and 8 are similar to the no-action alternative in that the current treatment systems would shut down. However, under Alternatives 2 and 8, LTM of the plume would continue and LUCs would be implemented.

Alternatives 3, 4, 5, and 6 consist of active treatment within the main body and the leading edge of the plume. Alternative 3 consists of active treatment by continuing to operate the existing treatment systems (In-Plume, Sandwich Road, and NL). Alternatives 4, 5, and 6 consist of active treatment by continuing to operate the existing treatment systems (In-Plume, Sandwich Road, and NL), plus additional active treatment that would include various combinations of the following:

- Extraction in the NCL – one additional extraction well located in the NCL;
- Extraction in the SL – one additional extraction well located in the SL; and
- In-Situ remediation in the SL – installation of a PRB in the SL.

Alternatives 9 and 10 consist of active treatment solely within the main body of the plume. Alternative 9 consists of operation of the existing main body ETR/ETI systems (In-Plume and Sandwich Road). Alternative 10 consists of operation of the existing main body ETR/ETI systems (In-Plume and Sandwich Road) and additional treatment in the CS-10 Southern Trench area.

Table 2-26 and Table 2-27 present a summary of the evaluation of the groundwater alternatives, and Table 2-28 and Table 2-29 present the model-predicted mass removed and time to cleanup for each alternative. Refer to the *Final CS-10 Groundwater Feasibility Study Addendum* (AFCEE 2007a) and the *Final Supplement to the CS-10 Groundwater Feasibility Study Addendum* (AFCEE 2008a) for further analysis including a complete listing of ARARs for each alternative and how individual alternatives would comply with them. ARARs for the selected remedy (Alternative 10 for the main body of the plume and Alternative 3 for the leading edge of the plume) are listed in Table 2-30, Table 2-31, and Table 2-32.

2.9.3 Expected Outcomes of the Alternatives

The expected outcome of Alternatives 1 through 6 can not be directly compared to Alternatives 7 through 10 because different groundwater models and plume shells were used. Based on current and reasonably anticipated future land use, human health risks are acceptable under all of the alternatives, except Alternatives 1 and 7. Alternatives 2 through 6 and 8 through 10 include implementation of LUCs, which will prevent residential exposure to the CS-10 plume. A more detailed description of the LUCs for CS-10 is presented in Section 2.11.2.

2.9.3.1 Alternatives 1 through 6

Groundwater modeling for Alternatives 1 through 6 was conducted using two models: the 2006 CS-10 flow and transport model (AFCEE 2006b) and the 2005 CS-10 Leading Edge Model (AFCEE 2005a). A TCE plume shell representing conditions for the main body of the plume (all of the plume upgradient of Sandwich Road) from June 2006 was used with the 2006 CS-10 model (AFCEE 2006b). The leading edge lobes (all of the plume downgradient of Sandwich Road) were represented by a TCE plume shell representing conditions as of January 2005 (AFCEE 2005a).

Modeling indicates that under Alternatives 1 and 2 the plume moves downgradient at concentrations higher than the cleanup standards, partially discharges to Ashumet Pond

and naturally attenuates. The plume eventually attenuates to concentrations below the cleanup levels by approximately 2113 for the main body and approximately 2044 for the leading edge. Modeling indicates that plume cleanup time frames for the remaining four active treatment alternatives (Alternatives 3 through 6) are approximately 2108 for the main body and 2046 for all of the leading edge. Within the leading edge there is variation in cleanup times for the specific leading edge lobes (Table 2-28).

2.9.3.2 Alternatives 7 through 10

Groundwater modeling for Alternatives 7 through 10 was conducting using the 2007 CS-10 groundwater flow model (AFCEE 2008a) and the 2007 main body TCE plume shell.

Modeling indicates that under Alternatives 7 and 8 the plume moves downgradient at concentrations higher than the cleanup standards, partially discharges to Ashumet Pond and naturally attenuates. The main body of the plume eventually attenuates to concentrations below the cleanup levels by approximately 2088. Modeling indicates that plume cleanup time frames for the remaining two active treatment alternatives (Alternatives 9 and 10) are approximately 2089 and 2094, but cleanup will likely be achieved sooner due to changes in system operations.

2.10 COMPARATIVE ANALYSIS OF CS-10 GROUNDWATER ALTERNATIVES

The following sections summarize the comparative analysis of the 10 CS-10 groundwater alternatives presented in the *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2008a) and of the *Final Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2007a).

2.10.1 Criteria For Detailed Analysis of Alternatives

The NCP (40 CFR, Part 300) presents nine criteria for analyzing the acceptability of a given alternative. These nine criteria are categorized as threshold criteria, primary

balancing criteria, and modifying criteria. The performance of the 10 CS-10 groundwater alternatives with respect to the threshold and primary balancing criteria are summarized in Table 2-26 and Table 2-27.

2.10.1.1 Threshold Criteria

There are two threshold criteria: overall protection of human health and the environment, and compliance with ARARs. Threshold criteria represent the minimum requirements that each alternative must meet to be eligible for selection.

Overall Protection of Human Health and the Environment - This criterion assesses the overall effectiveness of an alternative and focuses on whether that alternative achieves adequate protection and risk reduction, elimination, or control. The assessment of overall protection draws on assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs - Each alternative is assessed to determine whether it complies with ARARs under federal and state laws. Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations, unless such ARARs are waived under CERCLA Section 121(d)(4). Appendix C of the *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2008a) and Appendix A of the *Final Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2007a) outlines ARARs for all the CS-10 groundwater alternatives. ARARs for the selected alternative are listed in Table 2-30, Table 2-31, and Table 2-32.

2.10.1.2 Primary Balancing Criteria

The five primary balancing criteria are (1) long-term effectiveness and permanence; (2) reduction of toxicity, mobility, or volume through treatment; (3) short-term

effectiveness; (4) implementability; and (5) cost. Primary balancing criteria form the basis for comparing alternatives in light of site-specific conditions.

Long-Term Effectiveness and Permanence - Each alternative is assessed for its long-term effectiveness and the permanence of the solution. This criterion assesses the magnitude of residual risks remaining at the conclusion of remedial activities and the adequacy and reliability of controls to be used to manage residual risk.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Section 121 (Cleanup Standards) of CERCLA states a preference for remedial actions that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of contaminants as the primary element of the action. This criterion addresses the capacity of the alternative to reduce the principle risks through destruction of contaminants, reduction in the total mass of contaminants, irreversible reduction in contaminant mobility, or reduction in the total volume of contaminated media.

Short-Term Effectiveness - This criterion addresses the effects of the alternative during construction and operational phases until remedial objectives are met. Each alternative is evaluated with respect to its (potentially negative) effects on community health, worker safety, and environmental quality during the course of remedial actions. This criterion also addresses the time required by each alternative until remedial objectives are achieved.

Implementability - The implementability criterion is used to assess the technical and administrative feasibility of implementing an alternative. Technical issues include the reliability of the technology under consideration, potential construction difficulties, and the availability of required services, materials, and equipment (preferably from multiple sources). Administrative issues include permitting and access for construction and monitoring.

Cost - Costs associated with carrying out an alternative are based on current (present day) information escalated at a rate of 5 percent until year zero; after year zero, costs were

discounted (AFCEE 2007a and 2008a). Cost estimates included in this document are intended for comparative purposes only. The accuracy of the estimates are between -30 and +50 percent.

2.10.1.3 Modifying Criteria

There are two modifying criteria: state acceptance and community acceptance.

State Acceptance - The MassDEP has expressed its support for the selected remedy for the CS-10 groundwater plume, which is Alternative 3 for the leading edge of the plume and Alternative 10 for the main body of the plume.

Community Acceptance - The MMRCT supports the selected remedy for the CS-10 groundwater plume which is Alternative 3 for the leading edge of the plume and Alternative 10 for the main body of the plume.

2.10.2 Comparison of CS-10 Plume Alternatives

Six groundwater alternatives were evaluated in the CS-10 FS addendum (Alternatives 1 through 6) and four alternatives were evaluated in the supplement to the CS-10 FS addendum. Alternatives 1 and 7 are no-action alternatives, Alternatives 2 and 8 are limited-action alternatives, and Alternatives 3, 4, 5, 6, 9, and 10 consist of various active treatment scenarios. All of the alternatives (except for the no-action Alternatives 1 and 7) are protective of human health and the environment and comply with ARARs. All active remediation alternatives use proven technologies, will permanently remove contaminants, and pose low risk to workers, the community, and the environment (alternatives with greater construction have greater risk and more impact to the community and the environment). The alternatives differ in the amount of plume volume reduction and mass removed, time frames to reach cleanup levels in different areas of the plume, degree of inconveniences and disturbance that will be generated by construction and long-term activities, technical implementability, and costs. All the alternatives were evaluated against the nine NCP criteria. The following sections present the evaluation.

2.10.2.1 Overall Protection of Human Health and the Environment

AFCEE has already ensured protection of human health by providing municipal water supply hook-ups for all residences located above the CS-10 plume. Additional protection of human health is afforded by on-base LUCs, the Falmouth Board of Health (BOH) regulations, the Mashpee BOH regulations, MassDEP water supply regulations, and Dig Safe. The Falmouth regulations apply to new drinking water and irrigation wells but do not apply to use of existing wells. However, the LUCs developed ensure that there is no exposure to CS-10 plume. The LUCs prevent exposure of residents through existing wells by documenting the numbers of wells that may intercept the CS-10 plume and offering hook-ups to public water supply, abandonment of suspect wells, and monitoring. Therefore, for continuation of the current use of the aquifer, the risk to human health and the environment is the same for all alternatives, except for Alternatives 1 and 7 (no action).

2.10.2.2 Compliance with ARARs

The point at which chemical-specific ARARs are met would not be known under Alternatives 1 and 7 since monitoring would not be performed. All construction, treatment, and monitoring activities will be performed in accordance with location-specific and action-specific ARARs.

2.10.2.3 Long-Term Effectiveness and Permanence

The magnitude of residual risks and the adequacy and reliability of controls are similar for Alternatives 2, 3, 4, 5, 6, 8, 9, and 10: low residual risk because there are no untreated waste or treatment residuals. Reliability of controls is good for all alternatives because AFCEE has provided water supply connections to all on-base and off-base residences located above the CS-10 plume. Alternatives that include active treatment of the leading edge (Alternatives 3, 4, 5, and 6) may result in fewer uncertainties over the long term regarding the fate and transport of these portions of the plume.

All of the active treatment alternatives use proven and reliable technologies as an integral part of the treatment train. For the ETR/ETI systems, spent carbon is removed from the site and reactivated, thus, permanently destroying contaminants. At the conclusion of the remedy, groundwater concentrations will be below RAOs and, thus, pose minimal risk.

2.10.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Analysis of alternatives in the FS addendum indicates Alternatives 1 and 2 do not remove contaminants once treatment processes have ceased and, therefore, plume volume is reduced by natural attenuation only. The active treatment alternatives (3, 4, 5, and 6) have active treatment in the main body and the NL and thus satisfy the statutory preference that active treatment be a principal element in site remediation. Contaminants are permanently removed from the aquifer or permanently degraded. Treatment of the NCL is part of Alternatives 4, 5, and 6, and treatment of the SL is part of Alternatives 5 and 6. The FS addendum modeling predicted there were (as of January 2006) approximately 2,183 lb of TCE in the main body and 66 lb of TCE in the NL, NCL, and SL combined. The model predicted the existing main body CS-10 ETR/ETI systems would capture approximately 1,380 lbs, the NL extraction well would capture approximately 8.4 lbs, the NCL extraction well would capture approximately 2 lbs in Alternative 4 and approximately 0.9 lb in Alternatives 5 and 6, the SL extraction well would capture approximately 5 lbs, and the PRB reduced the TCE mass in the model by approximately 2 lbs. Decreases in plume volume at the leading edge are very similar for all of the alternatives.

Analysis of alternatives in the FS addendum indicates Alternatives 7 and 8 do not remove contaminants once treatment processes have ceased and, therefore, plume volume is reduced by natural attenuation only. The active treatment alternatives (9 and 10) have active treatment in the main body and thus satisfy the statutory preference that active treatment be a principal element in site remediation. Contaminants are permanently removed from the aquifer or permanently degraded. The model predicted Alternative 9 would capture approximately 1,125 lbs and Alternatives 10 would capture

approximately 1,191 lbs. Active treatment in the main body (Alternatives 9 and 10) rapidly decreases the plume volume of the main body.

2.10.2.5 Short-Term Effectiveness

Alternatives 1 and 7 have the least impact on workers, the community, and the environment since they do not require any new construction activities. Alternative 3 would have minimal impact on workers, the community, and the environment because it requires minimal new construction activities (a few monitoring wells). Alternatives 2 and 8 require installation of numerous monitoring wells, which will have an impact on the community and the environment. Alternatives 4, 5, 6, and 10 feature additional active remediation and would require site clearing, road grading, excavation, well installation, installation of a PRB in the case of Alternative 6, and routine maintenance and monitoring of the additional treatment system components. Of the alternatives focused on the leading edge of the plume, Alternatives 5 and 6 have the greatest impact since based on the conceptualization of the alternative; they would involve the most construction of any of the proposed alternatives. Of the active treatment alternatives focused on the main body, Alternatives 9 and 10 have similar impacts; Alternative 9 would have a greater number of monitoring wells installed in residential areas but Alternative 10 would have construction of an extraction well, reinjection well, and pipe installation.

Risks to workers under Alternatives 2 through 6 and 8 through 10 include hazards associated with drilling and construction and/or O&M of the treatment systems. Drilling and construction may take place in residential or conservation areas, so these alternatives carry additional short-term risks to the community. There are no known risks to the workers or the community that cannot be controlled or abated.

Environmental impacts include the following: site preparation (clearing and grading) for the extraction, reinjection, and monitoring wells or PRB; excavation for the well vaults; and those impacts associated with electricity generation. Environmental impacts associated with site work will be addressed by working with the state Natural Heritage

and Endangered Species Program to identify threatened and endangered species at the site and appropriate mitigation procedures; conducting cultural surveys as necessary; minimizing the area to be cleared, excavated, and graded; and reducing noise levels as much as possible. Environmental impacts that cannot be avoided include clearing, excavating, and grading; and increased electrical consumption during operation of the systems.

Time frames to reach cleanup levels vary depending on the presence or absence of active remediation system components. Modeling of alternatives in the FS addendum indicates contaminant concentrations would fall below the cleanup levels, through natural attenuation processes, under Alternatives 1 and 2 by approximately 2044 in the NL, 2025 in the NCL, 2027 in the SL, and 2017 in the area east of Johns Pond. Extraction in the NL (Alternatives 3 through 6) would increase the time to meet cleanup levels in the NL by approximately two years (approximately 2046), based on modeling predictions. Extraction in the NCL (Alternatives 4, 5, and 6) would decrease the time to meet cleanup levels in the NCL by approximately one year (2024), based on modeling predictions. Extraction in the SL (Alternative 5) would decrease the time to reach cleanup levels by approximately nine years (2018) in the SL, based on modeling predictions. Modeling predicts that in the SL, the contaminant concentrations would decrease below the cleanup levels by 2022 if a PRB were used (Alternative 6), which is five years sooner than if no remedial actions were taken in the SL.

Modeling of alternatives in the supplement to the FS addendum indicates contaminant concentrations in the main body would fall below the cleanup levels, through natural attenuation processes, under Alternatives 7 and 8 by approximately 2088 in the In-Plume area, by 2069 in the Sandwich Road area, and by 2085 in the Southern Trench area. Modeling predicts that active treatment in the main body (Alternative 9 and 10) would have no discernible reduction in time to reach cleanup levels for the In-Plume area (2089 and 2094, respectively), although it is likely that operating conditions will change with time and cleanup levels will be reached sooner in the In-Plume area than predicted in the model. Active treatment with the existing systems (Alternative 9) would decrease

the time to meet cleanup levels in the Sandwich Road area (2048) and the Southern Trench area (2023), based on modeling predictions. Simulation of additional extraction and reinjection (Alternative 10) in the model indicates the time to meet cleanup levels could decrease in the Sandwich Road area to 2038 and in the Southern Trench area to 2020.

2.10.2.6 Implementability

Alternatives 1 and 7 would require no action. Therefore, there are no technical or administrative implementability concerns for Alternatives 1 and 7. Alternatives 2 and 8 would have no technical implementability concerns because they would solely entail monitoring of the groundwater.

For Alternatives 3, 4, 5, 6, 9, and 10, the GAC technology is considered reliable and is currently being used in the existing CS-10 In-Plume treatment facility and SRTF, which have been operating since 1999 without significant technical difficulties. All aspects of Alternatives 1 through 10 are technically feasible. The PRB evaluated in Alternative 6 may have some technical implementability challenges related to the installation and modification of the PRB.

Administrative implementation for all alternatives (except Alternatives 1 and 7, no action) will include coordination with the towns of Falmouth and Mashpee (implementation of LUCs and work within public rights of way) and other agencies for technical update meetings, RPM meetings, and active communication on all issues of concern. The willingness of the towns of Falmouth and Mashpee, and private landowners to accommodate the remedial system on their property and the amount of site preparation is unknown. Access issues could potentially delay or even prevent active treatment in some areas. These access issues may negatively affect implementability for the active alternatives that employ system components that need to be built proportionally to the amount of construction required for each alternative.

2.10.2.7 Cost

For the FS addendum, Alternative 1 is the baseline scenario and, thus, no costs are associated with it. Of the alternatives from the FS addendum that meet the threshold criteria (all except Alternative 1), Alternative 2 is the lowest cost alternative [$27 million (M)] because it does not have any costs associated with active treatment of the plume. The most significant costs are associated with construction of additional treatment components (e.g., extraction wells, pipelines, PRB). The differences between present value costs for Alternative 3 ($59M), Alternative 4 ($60M), Alternative 5 ($62M), and Alternative 6 ($69M) are a result of the additional construction, O&M, and SPEIM costs associated with treatment in the leading edge. The costs of Alternatives 2 through 6 address costs for the main body and the leading edge.

For the supplement to the FS addendum, Alternative 7 is the baseline scenario and, thus, no costs are associated with it. Of the alternatives from the 2008 supplement to the FS addendum that meet the threshold criteria (all except Alternative 7), Alternative 8 is the lowest cost alternative ($9 M) because it does not have any costs associated with active treatment of the plume. The differences between present value costs for Alternative 9 ($29 M) and Alternative 10 ($30 M) are a result of the additional construction, O&M, and SPEIM costs associated with treatment in the Southern Trench area. The costs of Alternatives 8 through 10 address costs solely associated with the main body.

In support of the CS-10 PP and ROD, a cost estimate for the selected remedy was completed in a similar fashion to the costs estimated in the FS addendum and the supplement to the FS addendum. The present value cost of the selected remedy is $38 M and includes construction for treatment in the Southern Trench area, O&M for systems in the main body and the leading edge of the plume, and SPEIM for the main body and leading edge of the plume.

Between preparation of the cost estimate of the selected remedy (2008) and the cost estimate for Alternative 3 (2006) there were changes in the predicted O&M and monitoring costs that led to the significantly lower estimated cost of the preferred remedy

($38 M) compared to Alternative 3 ($59 M). The O&M costs are predicted to be lower due to savings in electricity cost from operation of the wind turbine AFCEE is currently installing and through energy conservation activities. The SPEIM monitoring and reporting costs have been reduced through efforts to make the monitoring and reporting more efficient.

2.10.2.8 State Acceptance

The MassDEP has expressed its support for the selected remedy for the CS-10 groundwater plume.

2.10.2.9 Community Acceptance

The MMRCT supports the selected remedy for the CS-10 groundwater plume. Comments were also received from a Falmouth private citizen and the Cape and Island Group Sierra Club. The comments and responses are provided in Section 3.0 Responsiveness Summary.

2.11 SELECTED REMEDY FOR THE CS-10 GROUNDWATER OPERABLE UNIT (OU)

Based on the Administrative Record for the CS-10 site and the evaluation of comments received by stakeholders during the public comment period, AFCEE has selected a combination of Alternative 3 for the leading edge and Alternative 10 for the main body as the remedy for the CS-10 groundwater OU. Since the supplement to the FS addendum was completed, the Air Force has designed, constructed, and operated (initiated February 2009) the new extraction and reinjection wells represented by Alternative 10.

2.11.1 Summary of the Rationale for the Selected Remedy

The selected remedy (Alternative 3 for the leading edge and Alternative 10 for the main body) consists of continued operation of the existing CS-10 treatment systems (Sandwich Road, In-Plume, and NL) and the CS-10 SPEIM program, the installation of a new extraction well in the Southern Trench area and a new reinjection well northwest of the

southern Sandwich Road extraction wells, and LTM and LUCs for the entire plume. The selected remedy is protective of human health through implementation of LUCs, complies with ARARs, does not have any significant implementability concerns, and has minor impacts on worker safety, the community, and the environment. The preferred remedy was selected over the other alternatives because it is expected to achieve the RAOs in a reasonable time frame and is cost-effective.

2.11.2 Detailed Description of Selected Remedy

The selected remedy (Alternative 3 for the leading edge and Alternative 10 for the main body) consists of the existing optimized In-plume ETI system, NL ETR system, and the Sandwich Road ETR system with the system expanded into the Southern Trench area with an additional extraction well and an additional reinjection well to improve capture of the plume in that area (Figure 2-8). The flow from the new extraction well will be treated at the SRTF and returned to the aquifer through the CS-10 and SD-5 reinjection wells. The flow to the new reinjection well will come from the CS-10 In-plume treatment facility via the Southern Infiltration Trench.

The ETR/ETI systems consist of ETR/ETI of groundwater following federal and state standards for TCE and PCE as stipulated in the current O&M plan. The alternative has the flexibility of modifying the treatment system to optimize the cleanup time frame and to insure it continues to meet performance objectives. Most likely, modifications would be executed with the existing extraction wells, reinjection wells, and infiltration trenches, and could involve the use of packers to reduce the effective vertical extent of the extraction screen, or adjusting flow rates. However, the alternative does not exclude the possibility of adding additional system components, if deemed necessary. Modifications would be made for the purpose of improving treatment system operation and expediting the plume cleanup.

This alternative would provide for chemical and hydraulic monitoring of the plume, as long as active remediation continues, and chemical monitoring of the plume until the RAOs are met. Monitoring data would aid in ongoing optimization and could prompt

additional action if COC concentrations did not decrease as expected. Monitoring results will be periodically reported in formal reports. CERCLA reviews would be performed every five years throughout the lifetime of the alternative. A residual risk assessment and/or an evaluation of the technical and economic feasibility of additional remediation to approach background concentrations would be performed, if deemed necessary. The selected remedy also includes implementation of LUCs.

The following text describes the LUCs that will be implemented for the CS-10 groundwater selected remedy. The CS-10 contaminated groundwater currently poses an unacceptable risk to human health if used for household purposes (i.e., ingestion, dermal contact, and inhalation of vapors released during household use of water).

The CS-10 contaminated groundwater is located in the southern part of the MMR cantonment area and a portion of the contaminated groundwater has migrated past the MMR boundary into the neighboring towns of Falmouth and Mashpee. Therefore, administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use, known as "LUCs," must be established for the CS-10 groundwater to avoid the risk of exposure to CS-10 groundwater. These LUCs are needed both on-base and off-base, within the towns of Falmouth and Mashpee, until the CS-10 contaminated groundwater no longer poses an unacceptable risk.

The performance objectives of the LUCs are to:

- Prevent access to or use of the groundwater from the CS-10 contaminated groundwater until the groundwater no longer poses an unacceptable risk, and
- Maintain the integrity of the current or future remedial or monitoring system such as the treatment systems and monitoring wells.

The LUCs will encompass the area including the CS-10 contaminated groundwater and surrounding areas to reduce the risk from exposure to contaminated groundwater (Figure 2-8). The on-base area of concern is controlled and operated by the USCG,

Army, and Air Force, who lease this land from the Commonwealth of Massachusetts. It is expected that these entities (USCG, U.S. Army, and U.S. Air Force) will control the on-base area of concern and the surrounding area for the duration of this ROD. As a result, the Air Force will coordinate with the Commonwealth of Massachusetts as the Air Force fulfills its responsibility to establish, monitor, maintain, and report on the LUCs for this site.

Each LUC will be maintained until either (1) the concentrations of COCs in the groundwater are at such levels as to allow unrestricted use and exposure, or (2) the Air Force, with the prior approval of the EPA and MassDEP, modifies or terminates the LUC in question.

The Air Force is responsible for ensuring that the following three LUCs are established, monitored, maintained, and reported on as part of this final remedy to ensure protection of human health and the environment in accordance with CERCLA and the NCP for the duration of the final remedy selected in this ROD. The Town of Falmouth has enforcement authority of the first LUC. The Town of Mashpee has enforcement authority of the second LUC. The Commonwealth of Massachusetts only has enforcement authority regarding the third LUC. In the event that the Town of Falmouth fails to promptly enforce the first LUC and/or the Town of Mashpee fails to promptly enforce the second LUC, or the Commonwealth of Massachusetts fails to promptly enforce the third LUC, the Air Force will act in accordance with the third to last paragraph in this section. For purposes of the preceding sentence, "promptly enforce" means if the violation or potential violation is imminent or on-going, enforce to prevent or terminate the violation within 10 days from the enforcing agency's (i.e., the Town or the Commonwealth) discovery of the violation or potential violation; otherwise, enforce as soon as possible.

(1) The Falmouth BOH requires a permit for the installation and use of all wells, including drinking water wells, irrigation wells, and monitoring wells. If a permit to install a drinking water well is approved, the Falmouth BOH will not approve the use of that well until its water has been tested and the BOH has determined that the water is potable. The Falmouth BOH Water Well Regulations do not apply to use of

existing drinking water wells and irrigation wells. The regulations, which are reproduced in Appendix C, include documented and anticipated areas of contamination from the CS-10 plume. To assist the Town of Falmouth in the implementation of this LUC, the Air Force will meet with the BOH on an annual basis, or more frequently if needed, to provide and discuss plume maps that document the current and projected location of the CS-10 plume within the town of Falmouth. While Figure 2-8 shows the current area of LUCs in the town, the Falmouth BOH may modify the areas where the BOH may require additional well testing, and this LUC will apply to such areas even if they differ from the area shown in Figure 2-8.

(2) To better protect the public health and welfare of its citizens, the Mashpee BOH, adopted a moratorium on residential wells on 23 April 1998, amended 29 July 1999, in the town of Mashpee. The moratorium, as amended, applies to existing wells and potential future wells, and restricts any and all uses of groundwater (Appendix D). The areas where well use is excluded are defined by the Mashpee BOH, and include documented areas of contamination and anticipated areas of contamination from the CS-10 contaminated groundwater. To assist the Mashpee BOH in the implementation of this LUC, the Air Force will meet with the BOH on an annual basis, or more frequently if needed, to provide and discuss plume maps that document the current and projected location of the CS-10 contaminated groundwater within the town of Mashpee. While Figure 2-8 shows the current area of LUCs in the town, the Mashpee BOH may modify the areas subject to the moratorium or where the BOH may require additional well testing, and this LUC will apply to such areas even if they differ from the area shown in Figure 2-8.

(3) In addition to the towns of Falmouth and Mashpee BOH regulations, which generally apply to small water supply wells, existing LUCs also prevent the possible creation of a large potable water supply well. The MassDEP administers a permitting process for any new drinking water supply wells in Massachusetts that propose to service more than 25 customers or exceed a withdrawal rate of 100,000 gallons per day. This permitting process, which serves to regulate the use of the CS-10 contaminated groundwater for any withdrawals of groundwater for drinking water purposes, constitutes an additional LUC for this final remedy. This LUC applies to both on-base and off-base portions of CS-10.

The Air Force has provided municipal water supply hook-ups for all residences in areas of current or anticipated groundwater contamination. In conjunction with the Falmouth and Mashpee BOH regulations, the municipal water supply hook-ups significantly reduce the likelihood of exposure to contaminated groundwater from existing wells and from any future wells installed in areas of anticipated contamination. Additionally, the Air Force is responsible for ensuring that the following LUCs are established, monitored, maintained, reported on, and enforced as part of this final remedy to ensure protection of human

health and the environment in accordance with CERCLA and the NCP for the duration of this final remedy selected in this ROD.

(1) For the on-base area of concern, a prohibition on new drinking water wells serving 25 or fewer customers has been established and placed on file with the planning and facilities offices for the Massachusetts Air and Army National Guard and USCG (major tenants at the MMR). The prohibition will be applied to future land use planning per Air National Guard Instruction (ANGI) 32-1003, Facilities Board, Army National Guard Regulation 210-20, Real Property Development Planning for the Army National Guard, and Commandant Instruction Manual 11010.14, Shore Facility Project Development Manual.

(2) For the on-base area of concern, the Air National Guard has administrative processes and procedures that require approval for all projects involving construction or digging/subsurface soil disturbance, currently set forth in ANGI 32-1001, Operations Management. This procedure is a requirement of the Army National Guard and the USCG by the Air National Guard through Installation Support Agreements. The Air National Guard requires a completed AF Form 103, Base Civil Engineer Work Clearance Request (also known as the base digging permit), prior to allowing any construction, digging, or subsurface soil disturbance activity. All such permits are forwarded to the IRP for concurrence before issuance. An AF Form 103 will not be processed without a Dig Safe permit number (see next paragraph).

(3) The Dig Safe program implemented in Massachusetts provides an added layer of protection to prevent the installation of water supply wells in the CS-10 groundwater area and to protect monitoring wells and the treatment system's infrastructure. This program requires, by law, anyone conducting digging activities (e.g., well drilling) to request clearance through the Dig Safe network. The Air Force at the MMR is a member utility of Dig Safe. The CS-10 groundwater plume is encompassed by a geographical area identified by the Air Force as a notification region within the Dig Safe program. Through the Dig Safe process, the Air Force will be electronically notified at least 72 hours prior to any digging within this area. The notification will include the name of the party contemplating, and the nature of, the digging activity. The Air Force will review each notification and if the digging activity is intended to provide a well, which has not been approved via the procedures above, the Air Force will immediately notify the project sponsor (of the well drilling), the EPA, the Falmouth BOH or the Mashpee BOH, and the MassDEP in order to curtail the digging activity. If the Dig Safe notification indicates proposed work near monitoring wells or the treatment system infrastructure, the Air Force will mark its components to prevent damage due to excavation. This LUC applies to both on-base and off-base portions of the CS-10 plume. The extent of the Air Force's enforcement of this LUC does not address off-base parties failing to file a Dig Safe request nor Dig Safe improperly processing a notification, but if incidents do occur, the Air Force is responsible for ensuring remedy integrity and, if necessary, repairing damage caused by third parties to the remedial system infrastructure or monitoring wells.

The LUCs are intended to prevent exposure to groundwater impacted by the CS-10 plume; however, to insure that the LUCs obtain the LUC performance objectives the Air Force will take the following action.

Within three years of the signing of the ROD, the Air Force shall:

a. Document all private wells (i.e., non-decommissioned wells, including wells not currently in use) that are above or within the projected path of the CS-10 plume.
b. Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the CS-10 plume, or test the private well for contamination and demonstrate the private well to be safe for human use. The Air Force will continue such testing, on an appropriate frequency as determined in coordination with the EPA, until the plume no longer presents a threat to that well as determined in coordination with EPA.
c. If the Air Force identifies a well containing COCs, the Air Force shall assess the risk that current and potential future non-drinking uses of such a well pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA for review and approval.
d. If neither b nor c is able to confirm that the identified well is safe for human use, the Air Force will offer the owner decommissioning of the well. If accepted, the Air Force will document such action with the appropriate BOH. If the decommissioning is not accepted, the Air Force will take other steps to insure protectiveness to include, but not be limited to, requesting assistance from the appropriate BOH to issue health warnings to the property owner and any other person with access to the well (such as a lessee or licensee), offering bottled water (if well is used for drinking), or installing treatment systems on affected wells. In each instance, the Air Force shall submit a schedule subject to EPA concurrence, outlining and including time limitations for the completion of steps sufficient to prevent exposure to concentrations of contaminated groundwater from the CS-10 plume having carcinogens in excess of ARARs (i.e., MCLs, non-zero MCLGs), and prevent exposure to groundwater from the CS-10 plume that poses a cancer risk in excess of the EPA target risk range of 10^{-4} to 10^{-6} or which presents a non-carcinogenic HI greater than one.

Monitoring of the environmental use restrictions and controls will be conducted annually by the Air Force. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the EPA and MassDEP for informational purposes. The annual monitoring reports will be used in preparation of the five-year review to evaluate the effectiveness of the final remedy.

The annual monitoring report, submitted to the regulatory agencies by the Air Force, will evaluate the status of the LUCs and how any LUC deficiencies or inconsistent uses have been addressed. The annual evaluation will address (1) whether the use restrictions and controls referenced above were effectively communicated, (2) whether the operator, owner, and state and local agencies were notified of the use restrictions and controls affecting the property, and (3) whether use of the property has conformed with such restrictions and controls and, in the event of any violations, summarize what actions have been taken to address the violations.

The Air Force shall notify the EPA and MassDEP 45 days in advance of any proposed land changes that would be inconsistent with the LUCs objectives or the final remedy. If the Air Force discovers a proposed or ongoing activity that would be or is inconsistent with the LUCs objectives or use restrictions, or any other action (or failure to act) that may interfere with the effectiveness of the LUCs, it will address this activity or action as soon as practicable, but in no case will the process be initiated later than 10 days after the Air Force becomes aware of this breach. The Air Force will notify the EPA and MassDEP as soon as practicable, but no later than 10 days after the discovery of any activity that is inconsistent with the LUCs objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs. The Air Force will notify the EPA and MassDEP regarding how the Air Force has addressed or will address the breach within 10 days of sending the EPA and MassDEP notification of the breach.

For the LUCs identified and selected for this ROD, the Air Force will provide notice to the EPA and MassDEP at least six months prior to relinquishing the lease to the CS-10 groundwater area so the EPA and MassDEP can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective LUCs. If it is not possible for the Air Force to notify the EPA and MassDEP at least six months prior to any transfer or sale, then the Air Force will notify the EPA and MassDEP as soon as possible, but no later than 60 days prior to the transfer or sale of any property, subject to LUCs.

The Air Force shall not modify or terminate LUCs, implementation actions, or modify land use without approval by the EPA and MassDEP. The Air Force, in coordination with other agencies using or controlling the CS-10 plume area, shall seek prior concurrence before taking any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs. The Air Force will provide EPA and MassDEP 30 days' notice of any changes to the internal procedures for maintaining LUCs which may affect CS-10.

2.11.3 Cost Estimate for the Selected Remedy

A cost estimate was developed for the final remedy (Table 2-33 and Table 2-34) because the costs from Alternative 3 and Alternative 10 overlapped with respect to O&M and monitoring of the main body of the plume and therefore the costs for Alternative 3 and 10 could not be simply added together. The information for the cost estimate is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements may occur based on alterations in operation of the CS-10 ETR/ETI systems and the monitoring program. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost. The cost comes from the O&M of the CS-10 ETR/ETI systems, the SPEIM program, periodic CERCLA reporting, and the residual risk assessment. AFCEE has begun implementation of this alternative to accelerate the cleanup of the plume; and thus, some of the funds in the cost estimate have already been accrued.

O&M costs would be incurred for the operation of the CS-10 ETR/ETI systems from the date the ROD is signed to 2055, when the treatment system is expected to cease operations. O&M costs have been estimated using actual costs realized for the previous operation of the existing CS-10 ETR/ETI systems and projected costs for future operations. The cost projections include expected future reductions in the total pumping rate and influent concentrations under the future operating conditions assumed for the purposes of this ROD.

Costs related to monitoring well maintenance, hydraulic measurement, sample collection, and groundwater analysis also would be incurred during this time. Groundwater monitoring could continue after the cleanup levels are met to ensure the aquifer had been restored. It is assumed (for cost-estimating purposes) that monitoring would continue for the entire plume for two years after the cleanup levels are met, making the total lifetime of this alternative 87 years. It is assumed that the number of monitoring points and frequency of testing would both continue to decrease with plume collapse, as has been the case under most SPEIM programs at the MMR to date. Monitoring costs include periodic reporting of results in technical update meetings and in formal reports.

Costs did not include those associated with potential LUCs because they were not determined until after the FS was completed. Additionally, no costs were included for negotiating and compensating for legal access to off-base property (for new monitoring wells). These omissions are anticipated to have a small impact on the overall net present value.

Costs associated with CERCLA reporting and a final risk assessment are also included in this alternative. The present value of this alternative is estimated to be $38 M.

Capital, annual, and periodic costs generated in the cost estimates and used in the present value calculations were assumed to start at the projected date of the ROD approval (2009). Cost estimates also included estimates from 2005 and 2006 that were escalated to the start of the base year (2009); thus, escalation of one year at a rate of 5 percent has been used. A discount rate of 2.8 percent was used for all present value calculations per EPA guidance (EPA 2000b) and Office of Management and Budget Circular A-94, revised January 2008 (OMB 2008).

2.11.4 Expected Outcomes of the Selected Remedy

The selected remedy (Alternative 3 for the leading edge and Alternative 10 for the main body) provides for protection of human health through implementation of LUCs. The groundwater model indicates that cleanup levels will be met by approximately 2094 for

the main body and 2046 for the leading edge (although it is likely that operating conditions will change with time and cleanup levels will be reached sooner than predicted in the model), at which time the groundwater will be useable as a source of drinking water.

2.12 STATUTORY DETERMINATIONS FOR THE CS-10 GROUNDWATER OPERABLE UNIT (OU)

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs (unless a waiver is justified), be cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. The following sections discuss how the selected remedy meets these statutory requirements.

2.12.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment through LUCs and monitoring of the groundwater plume to ensure contaminant concentrations are dissipating to below cleanup levels, as predicted by the groundwater model. Monitoring and LUCs reduce exposure to groundwater from the CS-10 plume. Human health is adequately protected currently by municipal water provided to residences overlying or in the immediate vicinity of the CS-10 plume. There are no short-term threats associated with the selected remedy that cannot be readily controlled.

2.12.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARAR)

Operation of the CS-10 ETR/ETI systems with addition of extraction in the Southern Trench area would remediate part of the plume, and the remainder of the plume contaminants would naturally attenuate to concentrations below the cleanup levels; therefore, the selected remedy would meet the chemical-specific ARARs.

Location-specific ARARs address federal and state regulations that aim to protect wildlife habitats, historical resources, and vital waterways. These areas have already been addressed during implementation of the existing ETR/ETI systems and will be followed for the construction of the new extraction well and reinjection well.

For this alternative, action-specific ARARs apply to the discharge (infiltration/reinjection) of treated groundwater and the management of spent carbon and contaminated groundwater generated from sampling of wells or treatment plant maintenance. Because these same activities have been occurring for existing remedial actions at CS-10, appropriate procedures are already in place for the proper handling of these materials. It is expected that these practices would continue, and all action-specific ARARs would be met. Refer to Table 2-30, Table 2-31, and Table 2-32 for a listing of these ARARs.

2.12.3 Cost-Effectiveness

In AFCEE's judgment, the selected remedy for CS-10 groundwater is cost-effective. The overall effectiveness of the selected remedy was determined to be proportional to its costs and, hence, to represent a reasonable value for the money to be spent.

The cost-effectiveness for the CS-10 remedy was evaluated based on the data currently available for the CS-10 plume and the following considerations: (1) cleanup levels will be met by approximately 2094, if not sooner, (2) there will be a significant reduction in plume volume through treatment, (3) contaminants are permanently destroyed, (4) risks to workers, the community, and the environment would be easily controlled, and (5) there is a high degree of confidence that the existing controls can adequately handle potential problems.

2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy for the CS-10 plume provides the best balance of trade-offs among the alternatives considered in the FS addendum and the supplement to the FS addendum.

The selected remedy represents the maximum extent to which permanent solutions and treatment can be practicably utilized at the site because Alternatives 1 and 7 (no action), and Alternative 2 and 8 (LTM) would not expedite aquifer restoration. For the main body of the plume, Alternative 10 is preferable to Alternative 9 because it restricts further migration and expansion of the plume south of Sandwich Road and decreases the time to cleanup for that portion of the plume. For the leading edge, incremental improvements to the aquifer restoration time frame and risk reduction in the leading edge are not commensurate with the additional costs of active remediation in the leading edge.

Based on the evaluation criteria and the statutory mandates, AFCEE finds the selected remedy to be the most appropriate solution for the CS-10 plume. The treatment, monitoring, and controls included in selected remedy will demonstrate compliance with ARARs and protectiveness of human health and the environment. The contaminants removed from the aquifer are destroyed through active treatment and contamination remaining in the aquifer is reduced to acceptable levels through natural attenuation. The selected remedy does not present any significant short-term risks. There are no special implementability issues that make the selected remedy unacceptable.

2.12.5 Preference for Treatment as a Principal Element

The selected remedy treats the contamination present in the CS-10 plume. The contaminated groundwater is removed from the aquifer through extraction wells and piped to the treatment plants. Contaminants are removed from the groundwater through GAC filtration. The treated groundwater is returned to the aquifer via infiltration trenches or reinjection wells.

2.12.6 Five-Year Review Requirements

Five-year statutory reviews will be performed for the CS-10 plume, according to Section 121(c) of CERCLA and NCP Section 300.430(f)(4)(ii), which requires such reviews in those instances where the remedy results in any hazardous substances, pollutants, or contaminants remaining at the site in excess of levels that allow for

unlimited use and unrestricted exposure. The purpose of the five-year reviews is to revisit the appropriateness of the remedy in providing adequate protection of human health and the environment. The five-year reviews for the CS-10 groundwater OU will be part of the five-year reviews conducted for the CERCLA IRP sites on the MMR. The next five-year review covering the period 01 November 2007 through 31 October 2012 will be published in the spring of 2013.

2.13 DOCUMENTATION OF NO SIGNIFICANT CHANGES

The PP for the Groundwater at CS-10 (AFCEE 2009b) was released for public comment in January 2009. The PP identified AFCEE's preferred alternative as a combination of Alternative 3 for the leading edge and Alternative 10 for the main body.

AFCEE, the EPA, and the MassDEP reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the PP, were necessary.

3.0 RESPONSIVENESS SUMMARY

The Responsiveness Summary is on the following pages.

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MASSACHUSETTS MILITARY RESERVATION

Installation Restoration Program

JULY 2009

RESPONSIVENESS SUMMARY
for Groundwater at Chemical Spill-10

INTRODUCTION

The purpose of this *Responsiveness Summary* is to provide written responses to the comments received during the public comment period for the Proposed Plan for Groundwater at Chemical Spill-10. The public comment period started 08 January 2009 and extended through 06 February 2009.

Comments	Responses
Comments from the Massachusetts Military Reservation Cleanup Team	
The MMRCT heard a presentation on the CS-10 Proposed Plan in their December 10, 2008 meeting and further discussed the proposal in their January 14, 2009 meeting. The members are in concurrence with the proposed remedy for CS-10 (a combination of Alternatives 3 and 10).	AFCEE concurs.
However, the MMRCT wants to ensure that the US EPA and MA DEP ensure that the Air Force develops and implements a thorough and effective monitoring plan for the two "plumelets" that will not have active treatment - the southern lobe and the north central lobe. In addition, the MMRCT wants to ensure that there is a sufficient monitoring plan for the east side of Ashumet Pond. A robust plan will help detect any contamination that may be flowing under the Pond, a difficult area to model in particular, and will be an early warning for the public water supply wells located further downgradient.	AFCEE finalized a system performance and ecological impact monitoring plan that was approved by the EPA and MassDEP. The plan includes chemical monitoring of the North Central Lobe, the Southern Lobe, and east of Johns Pond. The system performance and ecological monitoring plan will be periodically reviewed, and if necessary, revised.

Comments	Responses
Comments from Ron Reif (citizen of Falmouth) – Dated 2/5/09 As a user of Falmouth's drinking water, a tax payer, and a recreational user of Ashumet Pond, I am interested in the environmental cleanup projects at the MMR. My comments on the Final Proposed Plan for Groundwater at MMR Chemical Spill 10, dated January 2009, are as follows:	
1) Page 4, Paragraph 3: This section states that contaminated water is processed through granular activated carbon (GAC). Prior to reinjection of the processed effluent, is the water tested to ensure that the GAC's contaminant removal efficiency is adequate? Additionally, are their preventive maintenance procedures in place to ensure the GAC is changed before saturation or breakthrough occurs? If so, this should be stated.	1) The vessels containing the GAC are oriented in trains consisting of two vessels in series; a lead vessel and a lag vessel. Monthly sampling is conducted at the influent, intermediate position, and effluent to determine when the carbon is saturated. This sampling determines when carbon change outs are necessary and provides data to determine mass removal. The second GAC vessel ensures no plume contaminants of concern are in the plant effluent. There is a comprehensive operations and maintenance plan, approved by EPA and MassDEP, for the all AFCEE MMR treatment systems, including the CS-10 ETR/ETI systems. The *Final Operations and Maintenance Plan for Groundwater Extraction and Treatment Systems* is available from AFCEE and can be found at http://www.mmr.org.
2) Page 4, Paragraph 5: The term NL is used and it is not listed/described in the glossary.	2) The acronym NL (Northern Lobe) is introduced and defined in the first paragraph of the Site Description and History on page 2 of the proposed plan. The Northern Lobe is the northern most leading edge lobe of the CS-10 plume and is identified on Figures 2, 3, and 4 within the proposed plan.
3) Page 4, Paragraph 6: This section states that an in-situ chemical oxidation (ISCO) pilot test was conducted and that an evaluation of the results will be performed in early 2009. Pending favorable results and if feasible, the ISCO process should be implemented to augment the preferred remedial action alternative. This should be explicitly stated	3) Pending the evaluation of the in-situ chemical oxidation (ISCO) pilot test, AFCEE may consider incorporating a larger ISCO system into the overall remedial strategy for the CS-10 plume. Revision of the selected remedy to include ISCO would result in an amendment to the Record of Decision or an Explanation of Significant Differences.

Comments	Responses
within the plan and included with the preferred remedial action alternative.	
4) Page 5, Figure 2: The main body of the CS-10 plume is shown on this drawing. The southern portion of the main plume (on the west side of Ashumet Pond) appears to be forming another lobe that could move into/under Ashumet Pond. How can the treatment and reinjection plan be optimized to prevent this from happening? This should be addressed in the plan.	4) Treatment of the southern portion of the main plume (on the west side of Ashumet Pond) will be conducted as part of the preferred remedy, specifically by the new extraction and reinjection wells shown as part of Alternative 10 (Figure 4, page 14 of the proposed plan). The preferred remedy began operation in February 2009.
5) Page 6, Paragraphs 1-2: This section states that the exposure pathways examined do not pose unacceptable risks. Ashumet Pond is stocked with trout, which are routinely caught and eaten. Please indicate if this exposure pathway (i.e., ingestion of game fish) has been evaluated.	5) As part of the human health risk assessment conducted for the CS-10 plume, exposure to recreationally consumed fish from Ashumet and Johns ponds was considered. It was estimated that fishing from Ashumet and Johns ponds is unlikely to be a significant exposure route because of the non-bioaccumulative nature of TCE, PCE, and other chlorinated organic compounds detected in groundwater. Therefore, the fishing pathway was not evaluated in the risk assessment. Please be advised that the Massachusetts Department of Public Health has posted fish consumption advisories due to elevated mercury levels in many ponds across Massachusetts, including Johns and Ashumet ponds. The mercury levels in these fish are not believed to be MMR related.
6) Page 13 and elsewhere: The terms ETR, ETI, NCL, and SL are used here and elsewhere and are not listed in the glossary.	6) The acronym ETR/ETI (extraction, treatment, and reinjection/extraction, treatment, and infiltration) is defined on page 1 and is in further explained on page 23 of the proposed plan. The acronyms NCL (North Central Lobe) and SL (Southern Lobe) are defined in the first paragraph of the Site Description and History on page 2 of the proposed plan.
7) Figure 4: The drawing for Alternative 10 shows a future extraction well at the southern portion of the CS-10 plume. To confine this portion of the CS-10 plume, additional reinjection wells should also be considered (see comment 4 above).	7) Alternative 10 does include a new reinjection well located northwest of the existing CS-10 Sandwich Road reinjection wells to improve hydraulic capture of the portion of the CS-10 plume located northwest

Comments	Responses
	of Ashumet Pond. The new extraction well in Alternative 10 will also extract some of the plume northwest of Ashumet Pond. Additional reinjection in the southern portion of the CS-10 plume, close to Ashumet Pond, was considered during conceptualization of Alternative 10 but was not included as part of the alternative due to possible deleterious effects on nearby areas. Specifically, the additional reinjection could have negative impacts on the U.S. Geological Survey Tracer Test Site, the Ashumet Valley plume, the Phosphorus plume, the Ashumet Pond phosphorus barrier, and the thallium and manganese long-term monitoring area, all of which are located northwest of Ashumet Pond. Alternative 10 is a balance of conflicting interests in a hydraulically sensitive area.
8) In various locations, the plan indicates that the design and placement of extraction and reinjection wells is optimized. A summary of the optimization process should be included in the plan, as this is a critical part of continually improving the overall chemical spill cleanup process, reducing costs, and reducing the duration of this remediation project. At an estimated cost of nearly $90 Million and with a completion date that is estimated to be beyond 2100 for the CS-10 plume cleanup, it is critical that the optimization process be technically sound, effective, and proactive.	8) AFCEE continues to implement optimization activities in all aspects of the cleanup program including treatment plant operations and maintenance, drilling and sampling of environmental media, plume management, and administrative functions. A current investigation is collecting data in support of optimizing the CS-10 In-plume ETI system. The present value cost of the preferred remedy is $38 million. The estimated cost for the preferred remedy is not a combination of the Alternative 3 costs ($59M) and the Alternative 10 costs ($30M) because both alternatives account for treatment and monitoring of the main body. The significantly lower estimated cost of the preferred remedy compared to Alternative 3 is due to changes in the predicted O&M and monitoring costs that occurred between preparation of the cost estimate of the preferred remedy (conducted in 2008) and the cost estimate for Alternative 3 (conducted in 2006). The O&M costs are predicted to be lower due to savings in electricity cost from operation of the wind turbine AFCEE is currently installing and energy conservation activities. The monitoring and reporting costs have been reduced through optimization.

Comments	Responses
	The groundwater model simulates a constant operating condition for the length of the simulation, which resulted in an estimated cleanup time of 2094 for the main body of the plume under the preferred remedy. Remedial system operation is continuously evaluated and optimized to improve remedial system performance and reduce cleanup up times; therefore, the time frame for total system operation will most likely decrease through future optimization and cleanup will be achieved sooner for the main body of the plume.
Comments from Cape Cod & the Islands Group – Sierra Club – Dated 2/5 and 6/09 The Cape Cod & the Islands Group- Sierra Club favors a combination of Alternative 10 (for main body) and Alternative 5 (for the leading edges of the Northern Lobe, North Central Lobe, and Southern Lobe ETR/ETI systems). The Air Force Center for Engineering and the Environment (AFCEE) and the regulators (EPA Region 1 and Ma. DEP) favor a preferred solution of Alt. 10 combined with Alt. 3 (ETR for NL and LTM for NCL and SL). We don't feel that AFCEE's modelling is convincing that the NCL and SL will not migrate east of Johns Pond and potentially threaten the zones of contribution of public/private water supplies. In the face of such uncertainty, it is the Sierra Club's national policy to follow the precautionary principle which would support active treatment of the leading edges of the NCL and SL. Thus we favor Alt. 6 for the leading edges. We are not persuaded that the NCL and SL leading edges will naturally attenuate or be trapped in impermeable layers under Johns Pond and thus not reach the eastern shore. Past sampling has show volatile COC contamination on the eastern side of Johns Pond which suggests that AFCEE models may not realistically represent what is happening under the ground. In addition, the TCE/PCE contaminants may be delayed by the impermeable fine sediment layers under Johns	AFCEE recognizes that there is some uncertainty associated with groundwater modeling. The hydrogeology of the aquifer in the area of Ashumet and Johns ponds is recognizably complex and there is some uncertainty with respect to groundwater flow in the area. In order to address some of the uncertainty a sensitivity analysis was performed on the leading edge Alternatives 3 and 4 and is documented in the *Final Chemical Spill-10 Groundwater Feasibility Study Addendum* (AFCEE 2007a). The sensitivity analysis focused on contaminant mass and hydraulic conductivity units in the leading edge of the plume. The TCE mass and highest concentration of the North Central Lobe (NCL) was more than doubled. The NCL was also initiated in the model such that it would not be impeded by low-hydraulic-conductivity units. Results of the sensitivity analysis indicated that the NCL would persist longer and the farthest downgradient extent of TCE concentrations above 5 ppb would reach approximately 3,100 feet upgradient of the Mashpee Village Water Supply Well. The TCE concentrations above 5 ppb would also remain beneath the maximum permitted rate capture zone (zone of contribution) of the Mashpee Village Water Supply Well. These results are also consistent with the conceptual site model for this portion of the aquifer and the CS-10 plume. Therefore, based on the sensitivity

Comments	Responses
Pond, but are not likely to be permanently trapped. Instead these sedimentary features could act as a liquid chromatography column and slowly leach out at low levels for a long time period. AFCEE's models are not well constrained by plume contaminant mass balances and this can lead to a wide range of future scenarios for the leading edges of the NCL and SL. Since the regulators don't have the capacity to independently verify these models using different boundary conditions and modelling assumptions on how the groundwater interacts with the subsurface geology, the Sierra Club feels that an independent group of scientists should conduct modelling using alternative boundary conditions and modelling assumptions to test AFCEE's conclusion that the leading edges of the NCL and SL will not move east of Johns Pond. Under the precautionary principle it is the obligation of the responsible party to convince the public and the regulators that their interpretation of the model results is accurate. The Sierra Club is an environmental advocacy group and we lack the technical expertise to carry out such an analysis. It is a well accepted scientific practice to use multiple modelling approaches to convert scientific information into public policy. This practice should be utilized in the CS-10 proposed plan for treatment options for the leading edge. Thanks for your consideration in this matter. Dr. David Dow Treasurer, Cape Cod and the Islands Group-Sierra Club Addendum: Since the underground geology on Cape Cod is fairly complex because of the influence of the glaciers and the heterogeneity in the saturated zone sediment structure is poorly sampled, it would be better scientific practice to provide a range of predictions (based on different potential transmissivity values) on where the leading edge for the NCL and SL	analysis and the conceptual site model the CS-10 plume is not predicted to have any impact on the public or private water supplies east of Johns Pond. Monitoring networks have been established to track plume migrations. Current monitoring east and west of Johns Pond will continue and will be used to evaluate the modeling predictions and the conceptual site model. If monitoring results indicate there is a significant departure from the modeling predictions or conceptual site model than further investigation and/or modeling may be conducted to verify that the selected remedy remains protective of human health and the environment and cleanup will be achieved in a reasonable time frame. Additional treatment may be considered if the selected remedy fails to be protective of human health and the environment and/or if cleanup of the plume will not be achieved in a reasonable time frame.

Comments	Responses
will occur in the future. The current practice in environmental sciences is to characterize the uncertainty in the predictions provided to managers/policy makers in order to go from risk analysis to risk management. At the W.R. Grace hazardous waste site in Acton, Ma. 1,2-dichloromethane showed up in town wells two miles away, despite models that predicted that the impermeable clay layer in the aquifer would prevent this from happening. Test borings had found such an impermeable layer, but was not able to detect the break or opening in the barrier that allowed the COC to move from the plant to the town well. Given the costs of sampling the underground sediment layer heterogeneity, we are never going to be able to characterize the interaction between groundwater contaminants and the subsurface geology adequately through simplistic models that are based upon assumptions of homogeneity/equilibrium conditions. One needs to approach modeling from a scenario perspective and characterize the uncertainty in the predictions.	
Comments from Cape Cod & the Islands Group – Sierra Club – Dated 2/5/09 This is David Dow. I live in East Falmouth, Massachusetts and I'm here representing the Cape Cod and Islands Group of the Sierra Club. We favor Alternative 10 for the main plume body and Alternative 5 for the leading edge, which would include active treatment for the leading edges of the North Central Lobe and the Southern Lobe. And of course there's an extraction system in place already for the Northern Lobe and there's a Sandwich Road treatment fence and treatment plant for the main body of the plume and also it'll deal with the new Southern Trench well. So, we agreed with the Air Force Center for Engineering and the Environment on the Alternative 10 part but we favor Alternative 5 over Alternative 3 for the leading edge. The reason that we opted for Alternative 5 is that we felt there was a lot of uncertainty about whether the North Central Lobe and Southern Lobe leading edges would reach east of	AFCEE recognizes that there is some uncertainty associated with groundwater modeling. The hydrogeology of the aquifer in the area of Ashumet and Johns ponds is recognizably complex and there is some uncertainty with respect to groundwater flow in the area. A sensitivity analysis was conducted on the leading edge Alternatives 3 and 4 in order to address some of the uncertainty. The results of the sensitivity analysis and the conceptual site model the CS-10 plume indicate the CS-10 plume is not predicted to have any impact on the public or private water supplies east of Johns Pond. Current monitoring east and west of Johns Pond will continue and will be used to evaluate the modeling predictions and conceptual site model. If monitoring results indicate there is a significant departure from the modeling predictions or the conceptual site model then further investigation and/or modeling may be

Comments	Responses
John's Pond, and given that uncertainty in the model we felt that following the precautionary principle it would be best to have active treatment for the leading edges of the North Central Lobe and the Southern Lobe. The other thing that we recommended in our comments, which I actually e-mailed before I came over, was that they have an independent group to evaluate the modeling of the future scenarios of whether the Southern Lobe and the North Central Lobe leading edges will actually extend to the east of John's Pond and not be either naturally attenuated or trapped by the fine grade sediments that lie underneath John's Pond. So that was one of the suggestions we had to -- based on what was in the proposed plan and the supporting information that's been recently provided to the public by the AFCEE. So that's the extent of my comments.	conducted to verify that the selected remedy remains protective of human health and the environment and cleanup will be achieved in a reasonable time frame. Additional treatment may be considered if the selected remedy fails to be protective of human health and the environment and/or if cleanup of the plume will not be achieved in a reasonable time frame. Please see response to previous comment.
Comments from Gilbert Woolley, Sierra Club Hazardous Waste Activist – Dated 2/6/09 The difficulties of predicting the movement of water beneath the surface of the Cape reminds me of events at what became a Superfund site at a WR. Grace plant in Acton Mass in the late seventies. A consultant constructed a beautiful 3D model made up of four sided pyramids. The transmission of water from Grace's giant wastewater pond was calculated from each pyramid to it's neighbors. The model showed that there would be no transmission to the north because there was an impermeable clay barrier. A few test borings had found what looked like such a barrier. Then 1-1-dichloromethane showed up in volume in a town well two miles or so to the north. There must have been a break or opening in the barrier. Not surprising, since the barrier was laid down when the New England ice sheet was retreating at the end of the last ice age. At that time, what is now sub-surface was the actual surface, and no doubt criss crossed by streams.	AFCEE recognizes that there is some uncertainty associated with groundwater modeling. The hydrogeology of the aquifer in the area of Ashumet and Johns ponds is recognizably complex and there is some uncertainty with respect to groundwater flow in the area. A sensitivity analysis was conducted on the leading edge Alternatives 3 and 4 in order to address some of the uncertainty. The results of the sensitivity analysis and the conceptual site model the CS-10 plume indicate the CS-10 plume is not predicted to have any impact on the public or private water supplies east of Johns Pond. Current monitoring east and west of Johns Pond will continue and will be used to evaluate the modeling predictions and conceptual site model. If monitoring results indicate there is a significant departure from the modeling predictions or the conceptual site model then further investigation and/or modeling may be conducted to verify that the selected remedy remains protective of human health and the

Comments	Responses
All sub-surface geology is an aproximation, since no one can afford to drill a sufficient number of test cores and when it comes to the movement of water even small deficiencies in data can ruin the model, as it did at Grace. Gilbert K, Woolley	environment and cleanup will be achieved in a reasonable time frame. Additional treatment may be considered if the selected remedy fails to be protective of human health and the environment and/or if cleanup of the plume will not be achieved in a reasonable time frame. Please see response to comments from the Cape and Islands Group of the Sierra Club.

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4.0 REFERENCES

ABB (ABB Environmental Services, Inc.). 1992a (October). *Final Phase I Sump Investigation Program Work Completion Report.* Prepared for HAZWRAP (Hazardous Waste Remedial Actions Program) and ANG/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA.

———. 1992b (April). *Interim Remedial Investigation, UTES BOMARC and BOMARC Area Fuel Spill (AOC CS-10 and AOC FS-24).* Prepared for HAZWRAP (Hazardous Waste Remedial Actions Program) and ANG/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA.

AEHA (United States Army Environmental Hygiene Agency). 1988. *Geohydrologic Study No. 38-26-0500-86: Camp Edwards, Massachusetts.*

AFCEE (U.S. Air Force Center for Engineering and the Environment). 2009a (March). Chemical Spill-10 2008 Summary Letter Report. Prepared by CH2M Hill for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2009b (January). Proposed Plan for Groundwater at Chemical Spill-10. Fact Sheet 2009-01.

———. 2008a (August). *Final Supplement to the Chemical Spill-10 Groundwater Feasibility Study Addendum.* A4P-J23-35BC02VA-M16-0025. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2008b (January). *Final Chemical Spill-10 2007 Southern Trench Technical Memorandum.* Prepared by CH2M Hill for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2007a (May). *Final Chemical Spill-10 Groundwater Feasibility Study Addendum.* A3P-J23-35Z04802-M16-0019. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2007b (October). CS-10 ISCO Pilot Test Work Plan. Project Note. Prepared by CH2M Hill for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2006a (November). *Draft Proposed Plan for Groundwater at Chemical Spill-10.* A4P-J23-35BC02VA-M25-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2006b (May). Chemical Spill-10 2006 Modeling Files. Letter and attachment sent from CH2M Hill to AFCEE/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA.

———. 2005a (October) *Final Chemical Spill-10 Leading Edge Technical Memorandum.* Prepared by CH2M Hill for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2005b (June). *Final Chemical Spill No. 10 Detail C Vadose Zone Characterization Report.* Prepared by Portage Environmental Incorporated for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2003a (September). *Final Remedial Action Report, Area of Contamination CS-10/FS-24, Massachusetts Military Reservation Cape Cod, Massachusetts.* Prepared by Environmental Chemical Corporation (ECC) for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2003b (August). *Final Chemical Spill-10 Groundwater Feasibility Study.* AFC-J23-35U40702-M14-0015. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2002 (July). *Final Ashumet Pond Trophic Health Technical Memorandum.* AFC-J23-35S18402-M17-0012. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2001a (October). Draft RAGS Part D Tables – CS-10 Remedial Investigation Risk Assessment. AFC-J23-35U40702-M14-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2001b (September). *Final Chemical Spill-10 Remedial Investigation Report.* AFC-J23-35U40702-M14-0005. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2000 (February). *Final TCE Groundwater Plume Time-Critical Removal Action Report.* AFC-J23-35S18805-M17-0007. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 1999a (October). *Preliminary Risk Evaluation for Storm Drain-5 (SD-5) and Adjacent TCE Plumes.* AFC-J23-35S18404-M18-0001. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 1999b (August). *Semiannual CS-10 Recirculating Well Pilot Test Systems Monitoring Report for First and Second Quarters of 1999.* AFC-J23-35S19214-G2-0001. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 1999c (July). *Final Record of Decision, Area of Contamination CS-10/FS-24 Source Areas.* Prepared by Hazardous Waste Remedial Actions Program for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

———. 1997 (August). Chemical Spill-10 (CS-10) Plume Response Decision. Fact Sheet. Prepared by AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

ANG (Air National Guard). 1995 (September). *Final Record of Decision for Interim Action Containment of Seven Groundwater Plumes at Massachusetts Military Reservation, Cape Cod, Massachusetts.* Prepared by Stone & Webster, Environmental Technology & Services for ANG MMR Installation Restoration Program, Otis Air National Guard Base, MA.

ASG (Automated Sciences Group). 1994 (September). *Final Risk Assessment Handbook.* Massachusetts Military Reservation, Cape Cod, Massachusetts. Prepared for Air National Guard Bureau, Massachusetts Military Reservation, Cape Cod, MA.

CDM (Camp Dresser and McKee Federal Programs Corporation). 1997 (December). *Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10/FS-24 (AOC CS-10 and AOC FS-24) Source Operable Units: CS-10A and CS-10B.* Prepared for AFCEE/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA. Submitted by HAZWRAP (Hazardous Waste Remedial Actions Program), Oak Ridge, TN.

———. 1996 (July). *Final Remedial Investigation, UTES/BOMARC and BOMARC Area Fuel Spill, AOC CS-10 Groundwater Operable Unit: CS-10D and Hydrogeologic Region II Study.* Prepared for AFCEE/MMR Installation Restoration Program and ANG, Otis Air National Guard Base, MA. Submitted by HAZWRAP (Hazardous Waste Remedial Actions Program), Oak Ridge, TN.

EPA (U.S. Environmental Protection Agency). 2000a. (November). EPA Region 9 Preliminary Remediation Goals (PRGs), November 2000 [http://www.epa.gov/region09/waste/sfund/prg/whatsnew.htm.].

_____. 2000b (July). *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study.* EPA 540/R-00/002.

_____. 2000c. Drinking Water Standards and Health Advisories. Office of Water. EPA 822-B-00-001. Summer.

———. 1999a (July). *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents.* OSWER 9200.1-23P.

_____. 1999b. (April). National Recommended Water Quality Criteria – Correction. EPA Office of Water. EPA 822-Z-99-001. .

_____. 1998. (April). Guidelines for Ecological Risk Assessment. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington D.C. EPA/630/R-95/002f. April, 1998.

_____. 1997. (June). *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final.* Environmental Response Team. Edison, NJ.

_____. 1996. Ecotox Thresholds. *ECO Update* 3 (2), Publication 9345.0-12FSI, January 1996.

_____. 1995. U.S. EPA Region I Risk Update. August 1995. No. 3.

_____. 1991a. Ecological Assessment of Superfund Sites: An Overview. *ECO Update* 1 (2). Publication 9345.0-05I. December 1991.

_____. 1991b. Human Health Exposure Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. Washington, DC.

_____. 1989. *Risk Assessment Guidance for Superfund*, Volume I, Part A: Human Health Evaluation Manual, Baseline Risk Assessment. Office of Emergency and Remedial Response. Washington, D.C.

EPA and Region 1, Department of the Air Force National Guard Bureau, and U.S. Coast Guard. 2002 (June). *Federal Facility Agreement (FFA) Under CERCLA S120 and RCRA S7003 for the Massachusetts Military Reservation (MMR)* as amended.

Harding Lawson Associates. 1999 (January). *Drainage Structure Removal Program Remedial Action Summary Report.* Prepared for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

IGR (Institute for Groundwater Research). 2001. *Final Report on the Deep Granular Iron Permeable Reactive Barrier Field Demonstration at Massachusetts Military Reservation.* Prepared by the Department of Earth Sciences, University of Waterloo for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

Mason Environmental Services. 1992 (November). Remedial Response Action for Building #344.

MassDEP (Massachusetts Department of Environmental Protection). 2000. *Massachusetts Drinking Water Standards and Guidelines.* Massachusetts Department of Environmental Protection.

_____. 1996. Guidance for Disposal Site Risk Characterization Under the MCP. Environmental Risk Characterization Interim Final Policy. April 22, 1996.

OMB (Office of Management and Budget). 2008 (January). *OMB Circular No. A-94, Appendix C, Discount Rates for Cost-effectiveness, Lease Purchase, and Related Analyses.* www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html.

OpTech. 1994 (June). *Plume Response Plan.* Prepared for the Plume Management Process Action Team.

TRET (Technical Review and Evaluation Team). 1996 (May). Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation.

Wentsel, R.S., T.W. La Point, M. Simini, R.T. Checkai, D.T. Ludwig, and L.W. Brewer. 1996. *Tri-Service Procedural Guidelines for Ecological Risk Assessments.* U.S. Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, MD.

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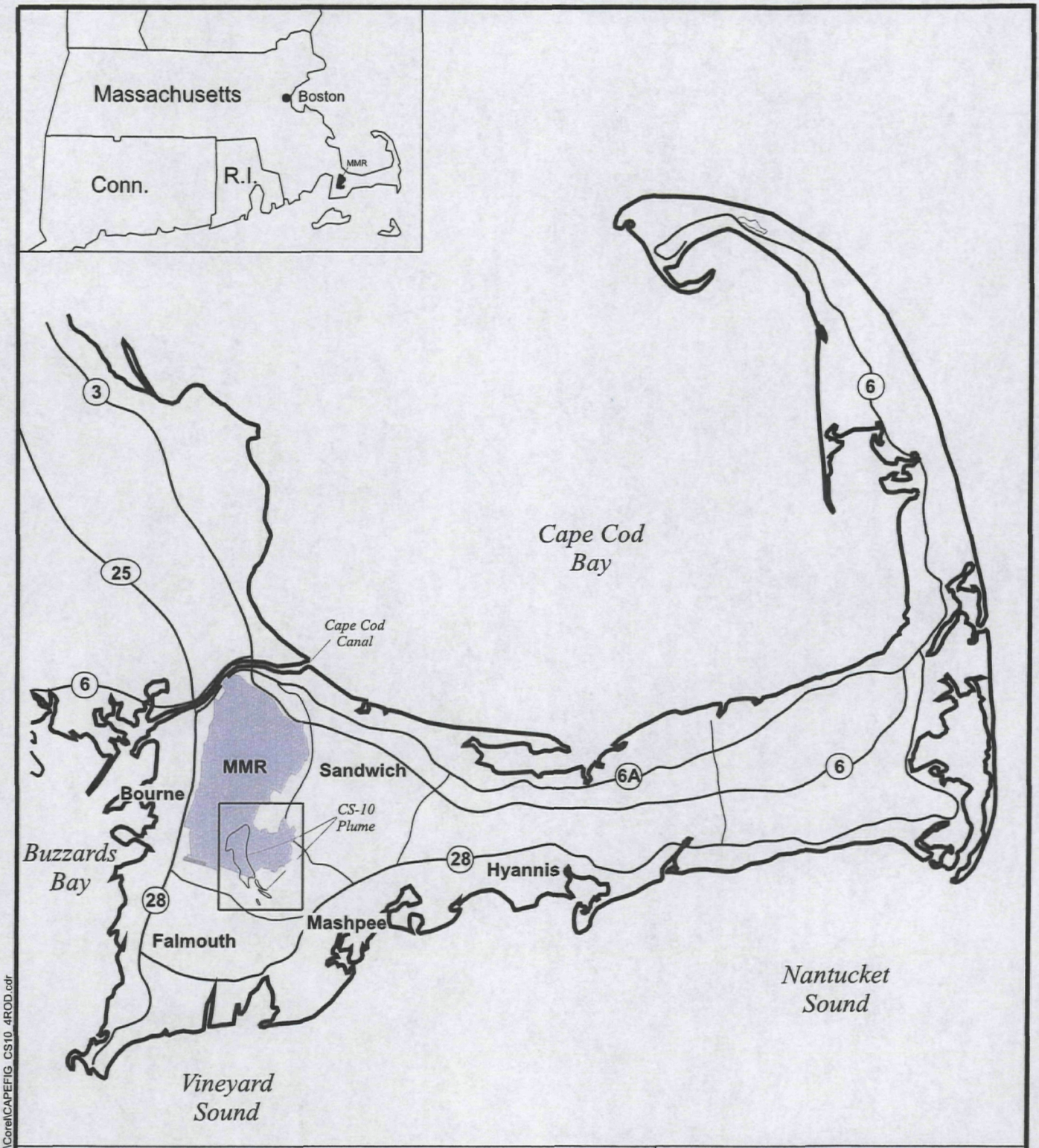
FIGURES



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Massachusetts Military Reservation
Cape Cod, Massachusetts

Massachusetts Military Reservation
Cape Cod, Massachusetts

2/23/08 JP File: CAPEFIG_CS10_4ROD.cdr

Figure 1-1

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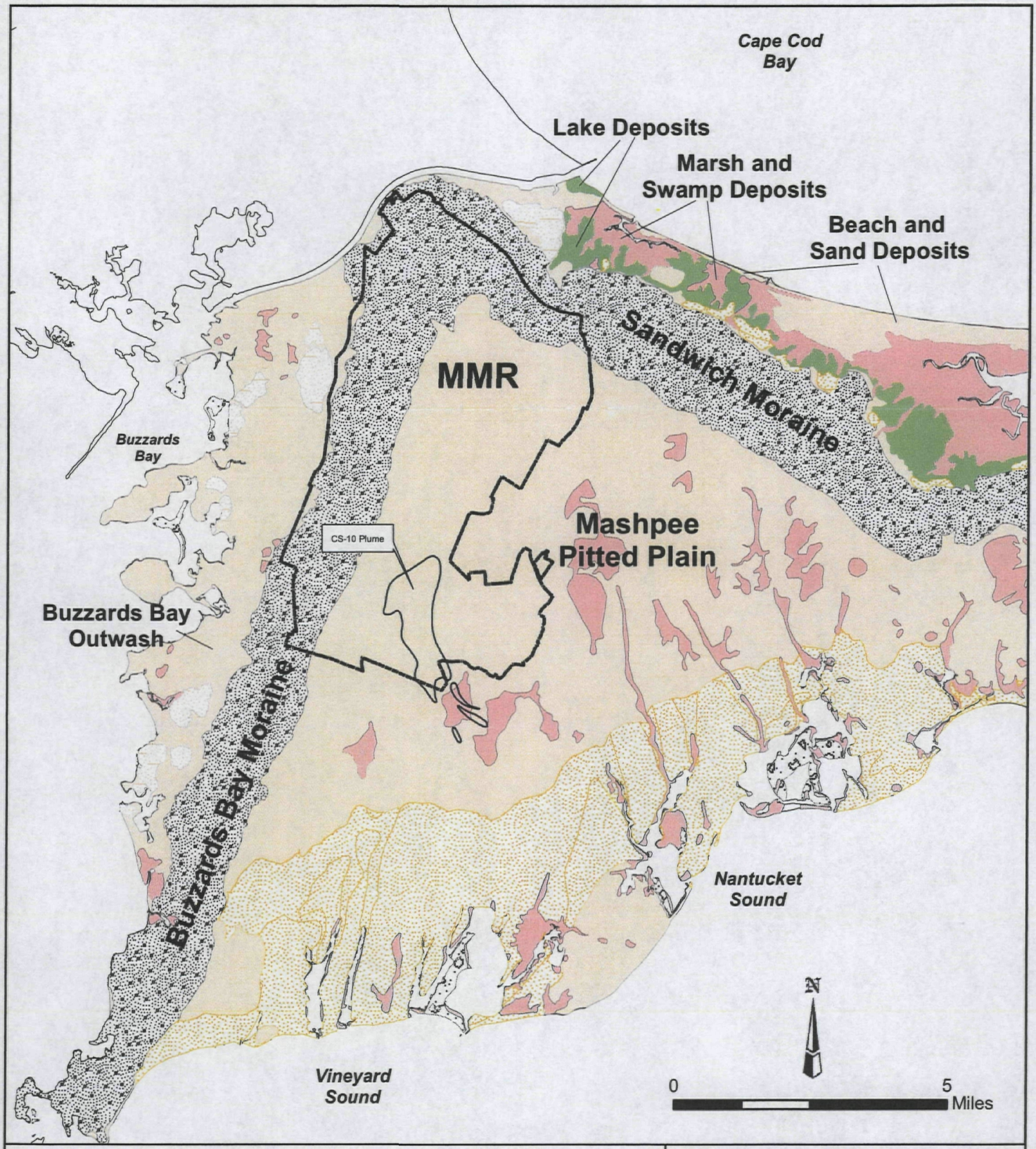

LEGEND

MMR Boundary

Surficial Geology Units

- end moraines
- fine-grained deposits
- floodplain alluvium
- large sand deposits
- sand and gravel deposits
- sandy till over sand
- till or bedrock

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Regional Surficial Geology Map and the Massachusetts Military Reservation

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 1/29/2009

Figure 2-1

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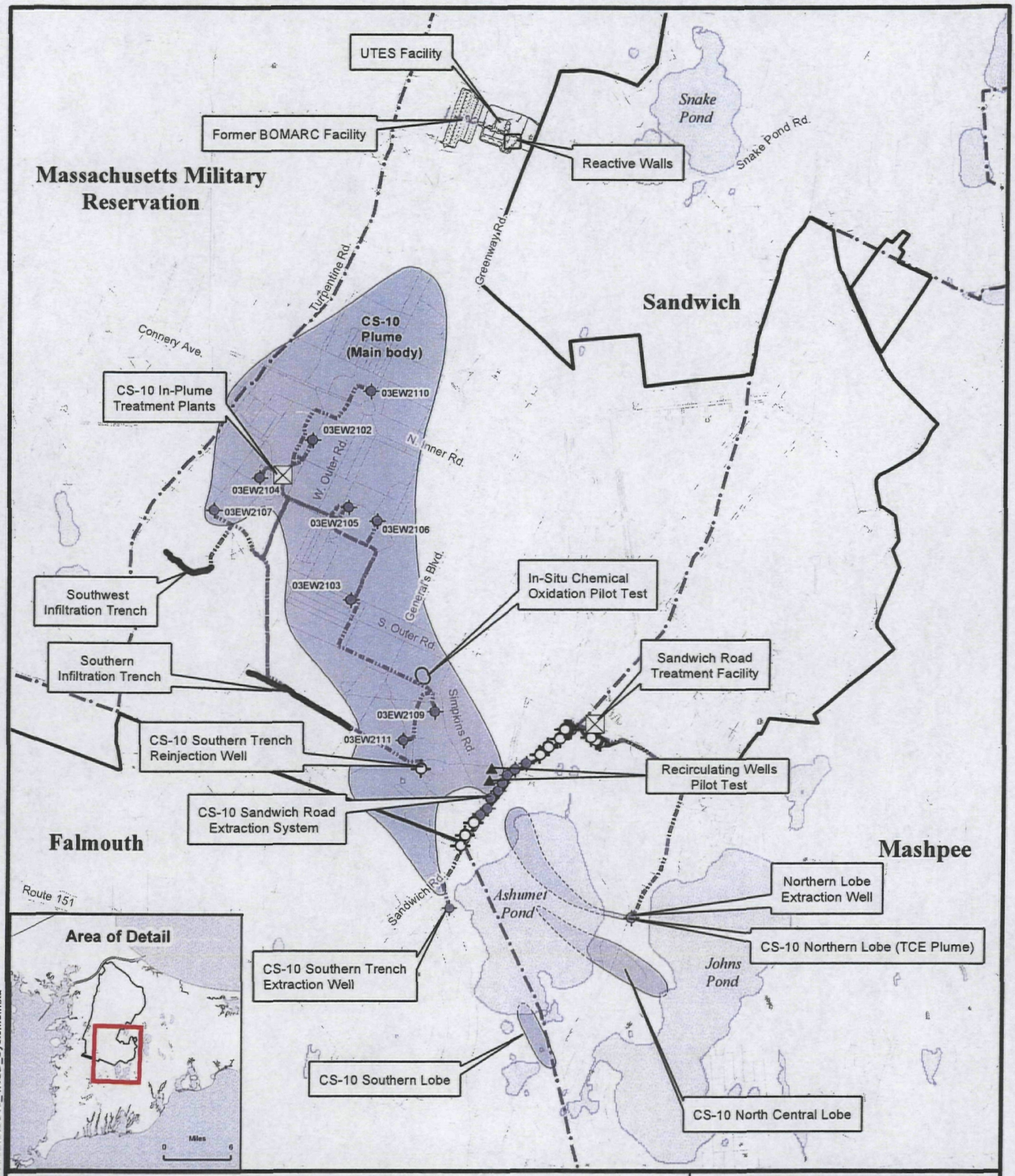

Legend

- Recirculating Well
- Extraction Well
- Reinjection Well
- Treatment Facility
- Town Boundary
- Massachusetts Military Reservation Boundary
- Treatment System Piping
- CS-10 Plume December 2007 (Dashed where inferred)

N

0 3,000 Feet

JACOBS™

CS-10 Plume and ETR/ETI Remedial System Layout

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 2/23/2009

Figure 2-2

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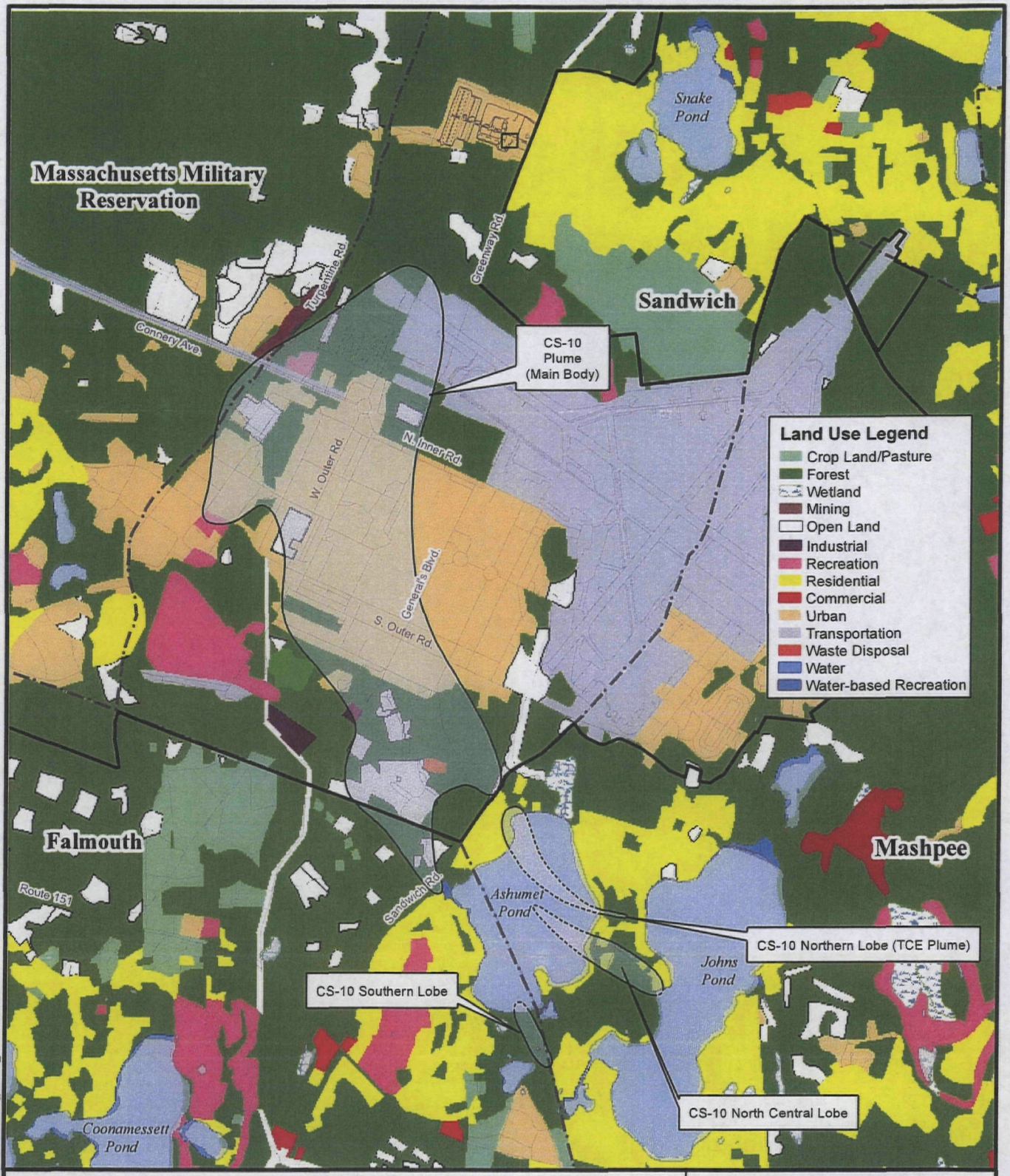

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- CS-10 Plume December 2007 (Dashed where inferred)

N

0 3,000 Feet

JACOBS™

CS-10 Area Land Use

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 2/23/2009

Figure 2-3

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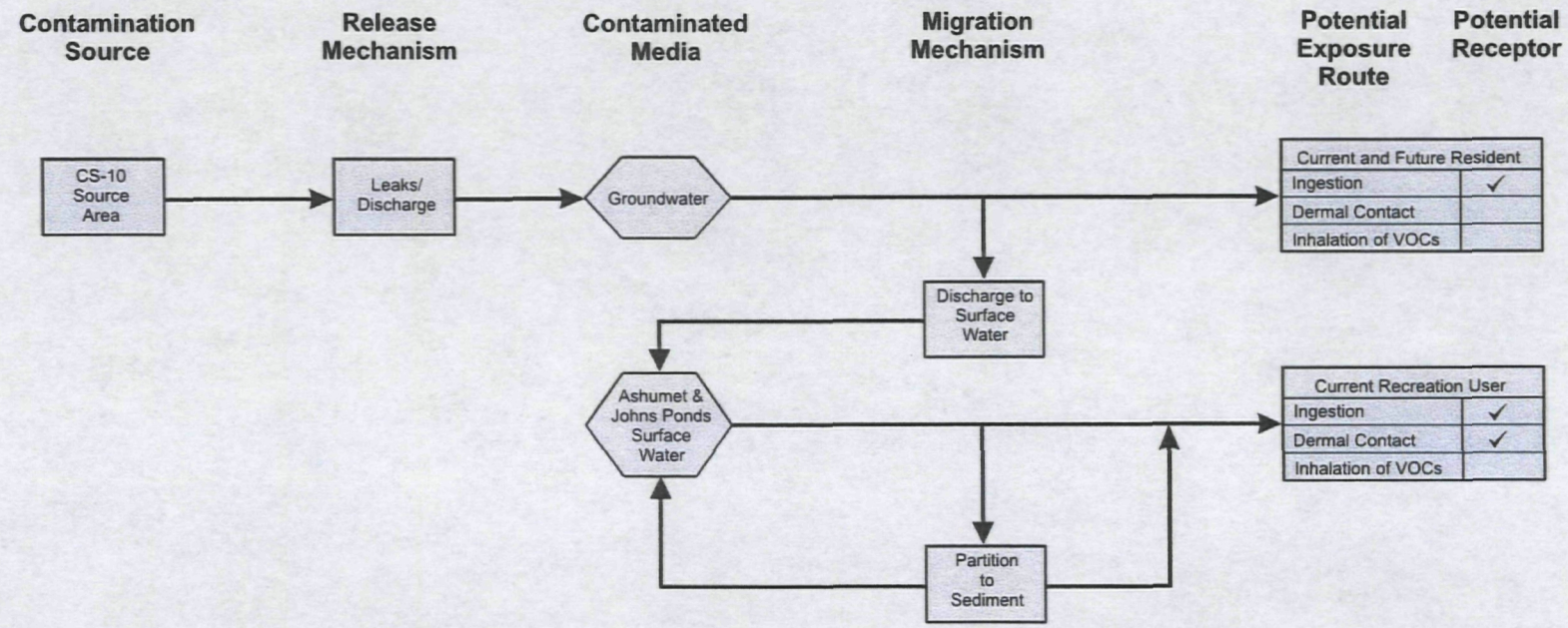

Legend

- Incomplete Pathway
- ✓ Complete Pathway

Note: Groundwater pathway is considered to be complete for purposes of this analysis. Residents overlying the plume are connected to a public water supply.

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Human Health
Conceptual Exposure Model
2001 CS-10 RI

Massachusetts Military Reservation
Cape Cod, Massachusetts

02/12/09 JP File: CS10_4ROD_2001-02.cdr

Figure 2-4

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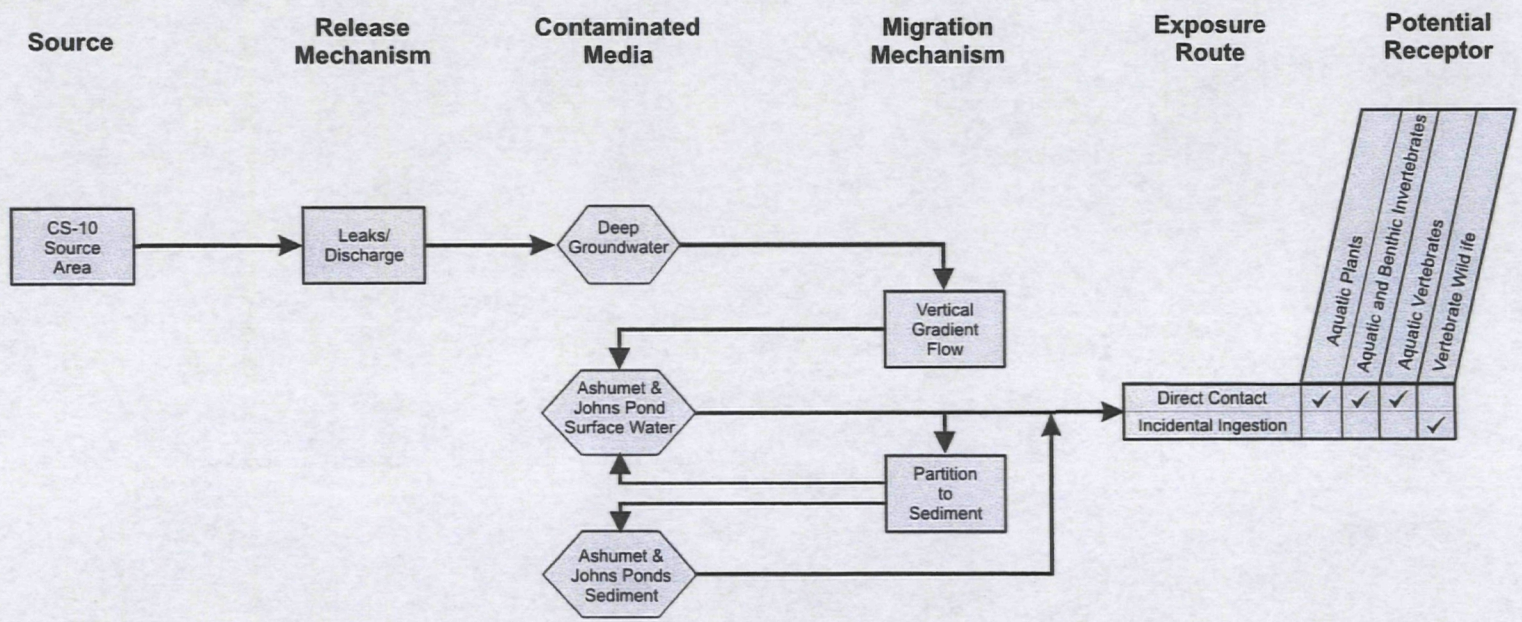

Legend

- Incomplete Pathway
- ✓ Complete Pathway

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Ecological
Conceptual Exposure Model
2001 CS-10 RI

Massachusetts Military Reservation
Cape Cod, Massachusetts

2/12/09 JP File: CS-10_4ROD_2001-04.cdr

Figure 2-5

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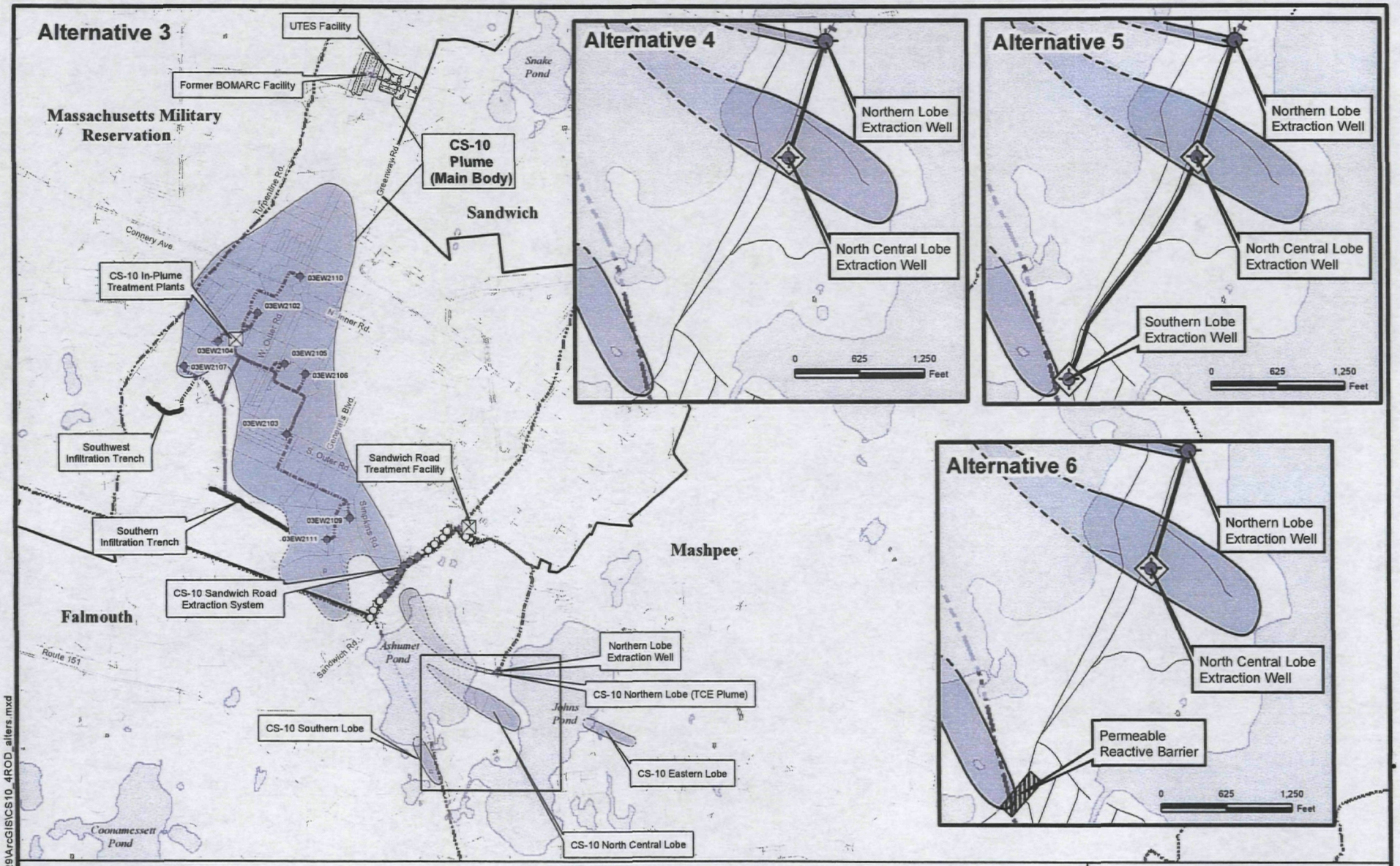
Alternative 3
UTES Facility
Former BOMARC Facility
Massachusetts Military Reservation
CS-10 Plume (Main Body)
Sandwich
Snake Pond
Turnpike Rd.
Greenway Rd.
Connery Ave.
CS-10 In-Plume Treatment Plants
03EW2110
03EW2102
03EW2104
03EW2107
03EW2105
03EW2106
03EW2103
03EW2109
03EW2111
W. Outer Rd.
N. Inner Rd.
S. Outer Rd.
Gaggwell's Blvd.
Simpkins Rd.
Southwest Infiltration Trench
Southern Infiltration Trench
Sandwich Road Treatment Facility
CS-10 Sandwich Road Extraction System
Falmouth
Route 151
Sandwich Rd.
Ashumet Pond
Mashpee
Northern Lobe Extraction Well
CS-10 Northern Lobe (TCE Plume)
Johns Pond
CS-10 Southern Lobe
CS-10 Eastern Lobe
CS-10 North Central Lobe
Coonamessett Pond
Alternative 4
Northern Lobe Extraction Well
North Central Lobe Extraction Well
0 625 1,250 Feet
Alternative 5
Northern Lobe Extraction Well
North Central Lobe Extraction Well
Southern Lobe Extraction Well
0 625 1,250 Feet
Alternative 6
Northern Lobe Extraction Well
North Central Lobe Extraction Well
Permeable Reactive Barrier
0 625 1,250 Feet
Legend
Monitoring Well
Extraction Well
Reinjection Well
Treatment Facility
Massachusetts Military Reservation Boundary
Treatment System Piping
Town Boundary
CS-10 Plume June 2006 (Dashed where inferred)
Future Extraction Well
Permeable Reactive Barrier
N
0 4,000 Feet
JACOBS™
CS-10 Groundwater Alternatives 3,4,5 and 6
Massachusetts Military Reservation
Cape Cod, Massachusetts
NAME: jpiccuit DATE: 1/29/2009
Figure 2-6
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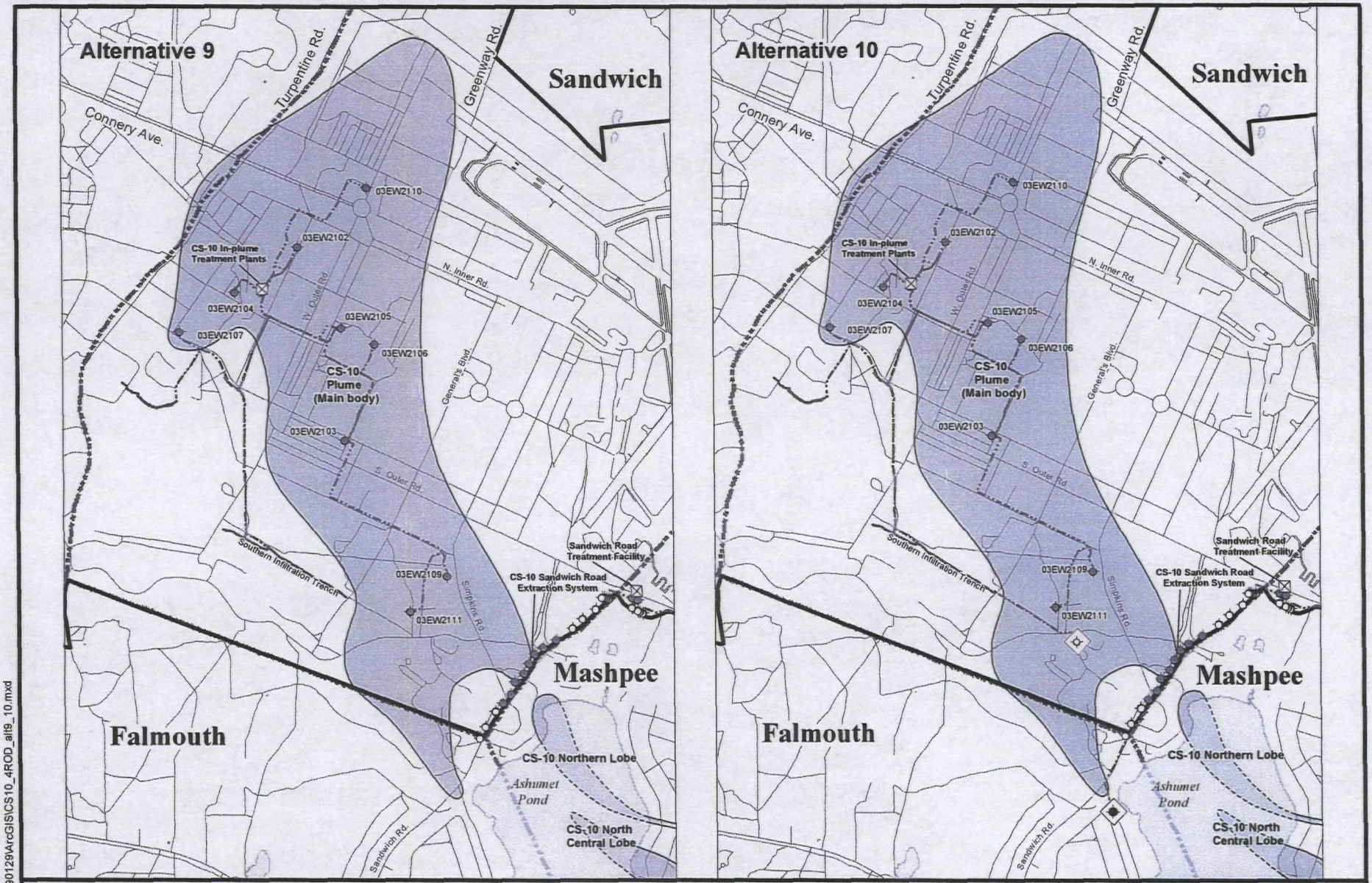

Legend

- Extraction Well
- Reinjection Well
- Future Extraction Well
- Future Reinjection Well
- Massachusetts Military Reservation Boundary
- Treatment System Piping
- Town Boundary
- CS-10 Plume December 2007 (Dashed where inferred)

N

0 2,500 Feet

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CS-10 Groundwater Alternatives 9 and 10

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 1/29/2009

Figure 2-7

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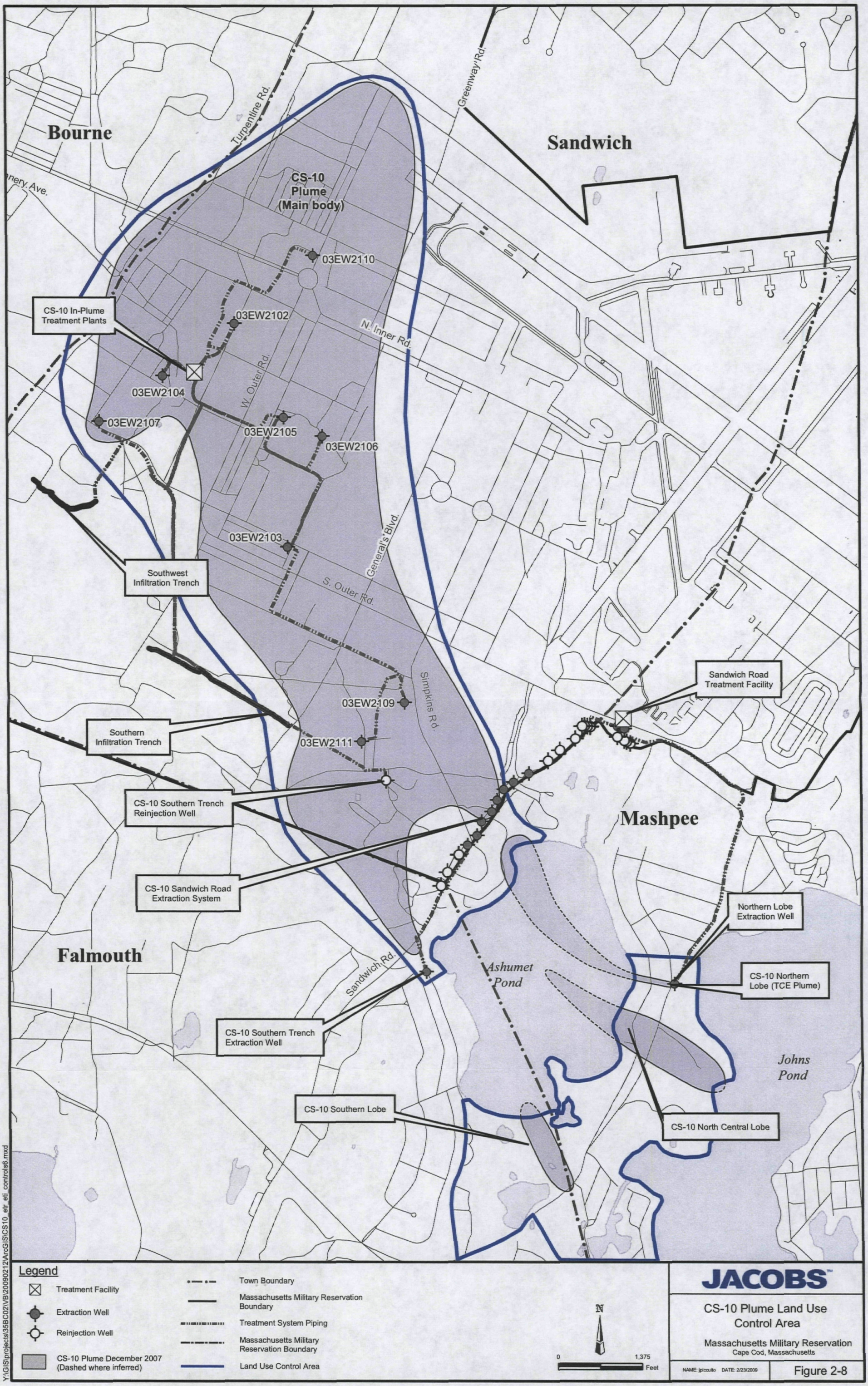
Bourne
Sandwich
Falmouth
Mashpee
Turpentine Rd.
Greenway Rd.
nery Ave.
CS-10
Plume
(Main body)
03EW2110
03EW2102
03EW2104
03EW2107
03EW2105
03EW2106
03EW2103
03EW2109
03EW2111
N. Inner Rd.
W. Outer Rd.
General's Blvd.
S. Outer Rd.
Simpkins Rd.
Sandwich Rd.
CS-10 In-Plume
Treatment Plants
Southwest
Infiltration Trench
Southern
Infiltration Trench
CS-10 Southern Trench
Reinjection Well
CS-10 Sandwich Road
Extraction System
CS-10 Southern Trench
Extraction Well
CS-10 Southern Lobe
Sandwich Road
Treatment Facility
Northern Lobe
Extraction Well
CS-10 Northern
Lobe (TCE Plume)
CS-10 North Central Lobe
Ashumet
Pond
Johns
Pond
Legend
Treatment Facility
Extraction Well
Reinjection Well
CS-10 Plume December 2007
(Dashed where inferred)
Town Boundary
Massachusetts Military Reservation
Boundary
Treatment System Piping
Massachusetts Military
Reservation Boundary
Land Use Control Area
N
0
1,375
Feet
JACOBS™
CS-10 Plume Land Use
Control Area
Massachusetts Military Reservation
Cape Cod, Massachusetts
NAME: jpiccuito DATE: 2/23/2009
Figure 2-8
Y:\GIS\projects\35BC02\VB\20090212\ArcGIS\CS10_etr_eti_controls6.mxd

TABLES

Table 2-1
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, TCE Plume

Scenario Timeframe:	Current (TCE Plume)
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located in TCE plume upgradient and downgradient of extraction well)

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
106-93-4	1,2-DIBROMOETHANE (EDB)	0.0027	U	0.036		µg/L	00DP0617, 79	6 : 254	0.0027 -- 0.005	0.036	N/A	0.000757 C	0.02	(a)	YES	E
NA	ALKALINITY, TOTAL (AS CACO3)	9690.0000	U	62,000.00		µg/L	95BH1251, 49.5	26 : 35	2200 -- 9690	62000.00	N/A	N/A	N/A		NO	G
7429-90-5	ALUMINUM (TOTAL)	11.00	U	114.75		µg/L	00MW0605C, -26.5	1 : 6	5.8 -- 16.6	114.75	N/A	50 N1	50	(a)	YES	C
7440-39-3	BARIUM	3.00	J	6.80	J	µg/L	00MW0605B, -56.19	6 : 6	0.3 -- 0.32	6.80	N/A	255 N	2000	(a)	NO	B
7440-39-3	BARIUM (TOTAL)	3.80	J	6.30	J	µg/L	00MW0605B, -56.19	6 : 6	0.3 -- 0.32	6.30	N/A	255 N	2000	(a)	NO	B
7440-42-8	BORON	33.60	U	68.60		µg/L	95BH1252, 2	10 : 35	6.1 -- 33.6	68.60	N/A	328 N	N/A		NO	B
7440-70-2	CALCIUM	2850.00		11,400.00		µg/L	00MW0609A, -79.13	6 : 6	28.1 -- 28.1	11400.00	N/A	N/A	N/A		NO	F
7440-70-2	CALCIUM (TOTAL)	2840.00		12,000.00		µg/L	00MW0609A, -79.13	6 : 6	28.1 -- 28.1	12000.00	N/A	N/A	N/A		NO	F
67-66-3	CHLOROFORM	0.08	U	0.92	J	µg/L	00MW0609B, -9.93	4 : 28	0.08 -- 0.08	0.92	N/A	0.0627 N	5	(a)	YES	C
18540-29-9	CHROMIUM (TOTAL)	0.60	UJ	1.83	J	µg/L	00MW0605B, -56.19	1 : 6	0.6 -- 0.62	1.83	N/A	11 N	100	(a)	NO	B
156-59-2	CIS-1,2-DICHLOROETHENE	0.08	U	5.59	J	µg/L	00BH0705, 132	38 : 257	0.08 -- 2.15	5.59	N/A	6.08 N	70	(a)	NO	B
7440-48-4	COBALT	0.59	U	5.00		µg/L	00MW0605B, -56.19	2 : 6	0.59 -- 0.59	5.00	N/A	219 N	N/A		NO	B
7440-50-8	COPPER (TOTAL)	0.83	UJ	4.80	J	µg/L	00MW0609B, -9.93	2 : 6	0.8 -- 0.83	4.80	N/A	136 N	1300	(a)	NO	B
100-41-4	ETHYLBENZENE	0.10	U	0.80	J	µg/L	00DP0620, 75	5 : 233	0.096 -- 0.203	0.80	N/A	134 N	700	(a)	NO	A,B
7782-41-4	FLUORIDE	5240.00		63.00		µg/L	95BH1211, 9	1 : 2	15.6 -- 15.6	63.00	N/A	220 N	4000	(a)	NO	B
7439-89-6	IRON	15.60	U	6,150.00		µg/L	00MW0605B, -56.19	33 : 40	15.6 -- 15.6	6150.00	N/A	300 N1	300	(a)	NO	F
7439-89-6	IRON (TOTAL)	15.60	U	6,110.00		µg/L	00MW0605B, -56.19	5 : 6	15.6 -- 15.6	6110.00	N/A	300 N1	300	(a)	NO	F
7439-95-4	MAGNESIUM	1070.00		3,770.00		µg/L	00MW0605B, -56.19	6 : 6	21.8 -- 21.8	3770.00	N/A	N/A	N/A		NO	F
7439-95-4	MAGNESIUM (TOTAL)	1080.00		3,740.00		µg/L	00MW0605B, -56.19	6 : 6	21.8 -- 21.8	3740.00	N/A	N/A	N/A		NO	F
7439-96-5	MANGANESE	5.25	U	2,650.00	J	µg/L	95BH1251, 19.5	39 : 41	1 -- 5.25	2650.00	N/A	50 N1	50	(a)	YES	C
7439-96-5	MANGANESE (TOTAL)	4.60	U	324.00		µg/L	00MW0605A, -136.2	5 : 6	0.33 -- 4.6	324.00	N/A	50 N1	50	(a)	YES	C
75-09-2	METHYLENE CHLORIDE	0.08	U	0.89	J	µg/L	00MW0620C, -13.36	1 : 28	0.08 -- 0.08	0.89	N/A	4.28 C	5	(a)	NO	A,B
1634-04-4	METHYL-TERT-BUTYL-ETHER (MTBE)	0.09	U	4.60		µg/L	00MW0620A, -51.67	4 : 28	0.09 -- 0.18	4.60	N/A	2 N	20	(a)	YES	C
7440-02-0	NICKEL	1.40	U	9.30	J	µg/L	00MW0605B, -56.19	2 : 6	1.4 -- 1.4	9.30	N/A	73 N	100	(a)	NO	B
7440-02-0	NICKEL (TOTAL)	1.40	U	3.10	J	µg/L	00MW0609A, -79.13	2 : 5	1.4 -- 1.4	3.10	N/A	73 N	100	(a)	NO	B
7727-37-9	NITROGEN	51.50		3,240.00		µg/L	95BH1214, 46	35 : 35	8.7 -- 87	3240.00	N/A	N/A	N/A		NO	G
7664-41-7	NITROGEN, AMMONIA (AS N)	5.00	U	3,000.00		µg/L	95BH1214, 46	21 : 35	5 -- 50	3000.00	N/A	N/A	N/A		NO	G
14797-55-8	NITROGEN, NITRATE (AS N)	0.90	U	1,300.00		µg/L	95BH1211, 29	31 : 35	0.9 -- 18	1300.00	N/A	10000 N1	10000	(a)	NO	B
7723-14-0	PHOSPHORUS, DISSOLVED (AS P)	3.40		460.00		µg/L	95BH1211, 9	40 : 40	1.5 -- 7.5	460.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL HYDROLYZABLE (AS P)	1.30	U	387.00		µg/L	95BH1211, 9	29 : 32	1.3 -- 3	387.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL PO4 (AS P)	4.50		12.35		µg/L	95BH1256, 49	3 : 3	0.6 -- 0.6	12.35	N/A	N/A	N/A		NO	G
7440-09-7	POTASSIUM	1010.00	J	2,930.00		µg/L	00MW0605A, -136.2	6 : 6	46.3 -- 46.3	2930.00	N/A	N/A	N/A		NO	F
7440-09-7	POTASSIUM (TOTAL)	1220.00	J	3,310.00		µg/L	00MW0605A, -136.2	6 : 6	46.3 -- 46.3	3310.00	N/A	N/A	N/A		NO	F
7440-22-4	SILVER	0.80	UJ	1.60	J	µg/L	00MW0609A, -79.13	2 : 6	0.8 -- 0.8	1.60	N/A	18.3 N	100	(a)	NO	B
7440-22-4	SILVER (TOTAL)	0.80	UJ	1.60	J	µg/L	00MW0605B, -56.19	3 : 6	0.8 -- 0.8	1.60	N/A	18.3 N	100	(a)	NO	B
7440-23-5	SODIUM	6460.00		10,500.00		µg/L	00MW0605D, 14.05	6 : 6	98.8 -- 98.8	10500.00	N/A	20000 N1	20000	(a)	NO	B,F
7440-23-5	SODIUM (TOTAL)	7040.00		10,900.00		µg/L	00MW0605A, -136.2	6 : 6	98.8 -- 98.8	10900.00	N/A	20000 N1	20000	(a)	NO	B,F
18496-25-8	SULFIDE	530.00	U	860.00	J	µg/L	95BH1214, 116	3 : 35	530 -- 530	860.00	N/A	N/A	N/A		NO	G,H
127-18-4	TETRACHLOROETHENE(PCE)	0.10	U	6.29	J	µg/L	00BH0705, 122	66 : 257	0.1 -- 2.88	6.29	N/A	1.08 C	5	(a)	YES	C
108-88-3	TOLUENE	0.09	U	1.97		µg/L	00MW0620C, -13.36	18 : 257	0.09 -- 0.133	1.97	N/A	72.3 N	1000	(a)	NO	B
79-01-6	TRICHLOROETHENE(TCE)	0.09	U	2,352.00		µg/L	95BH1251, 99.5	174 : 257	0.09 -- 6.44	2352.00	N/A	1.64 C	5	(a)	YES	C
7440-62-2	VANADIUM (TOTAL)	0.96	U	1.10	J	µg/L	00MW0609A, -79.13	1 : 6	0.96 -- 1	1.10	N/A	25.6 N	N/A		NO	B
7440-66-6	ZINC	8.20	U	15.70	J	µg/L	00MW0605B, -56.19	5 : 6	1.9 -- 8.2	15.70	N/A	1090 N	5000	(a)	NO	B
7440-66-6	ZINC (TOTAL)	3.80	U	19.40		µg/L	00MW0609B, -9.93	5 : 6	1.9 -- 3.8	19.40	N/A	1090 N	5000	(a)	NO	B

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value.
N/A = Not Available.
U = Not Detected.
µg/L = micrograms per liter.
(1) Minimum/maximum detected concentration
(2) Maximum detected concentration used as screening value.
(3) Lowest water screening value available:
C - EPA Region 9 PRG, November 2000. Residential Tap Water: Carcinogens.
N - EPA Region 9 PRG, November 2000. Residential Tap Water: Non-carcinogens; based on a hazard quotient of 0.1.
N1 - EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.
(a) EPA Drinking Water Standards and Health Advisories, Summer 2000, Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.

(4) Rationale Codes
Reasons for elimination or selection
A - Frequency of detection is less than or equal to 5%.
B - Maximum detected concentration is less than water screening value.
C - Maximum detected concentration exceeds water screening value.
D - Screening values are not available.
E - Compound is retained because it is site-related.
F - Essential Nutrient.
G - General Chemistry Parameter.
H - Lack of toxicity criteria.

Table 2-2
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Current CS-10 Leading Edge Groundwater

Scenario Timeframe:	Current
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located upgradient of Ashumet Pond, between Ashumet and Johns ponds, and downgradient of Johns Pond - and not within TCE plume)

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
75-34-3	1,1-DICHLOROETHANE	0.07	U	0.93	J	µg/L	00MW0582A, -121.29	1 : 201	0.07 -- 0.07	0.93	N/A	81.10 N	70.00	(a)	NO	A,B
106-93-4	1,2-DIBROMOETHANE (EDB)	0.0024	U	0.039		µg/L	03MW2617B, -41.45	10 : 175	0.0024 -- 0.0051	0.039	N/A	0.00076 C	0.02	(a)	YES	C
106-46-7	1,4-DICHLOROBENZENE	0.0970	U	0.840	J	µg/L	00MW0589A, -197.69	5 : 200	0.097 -- 0.097	0.84	N/A	0.50 C	5.00	(a)	NO	A
106-44-5	4-METHYLPHENOL (P-CRESOL)	0.5100	U	1.100	J	µg/L	00MW0584C, 32.82	1 : 31	0.51 -- 0.51	1.10	N/A	18.30 N	N/A		NO	A,B
67-64-1	ACETONE	0.7100	U	7.130	J	µg/L	ECMWAMP05A, -44.47	1 : 4	0.71 -- 2.82	7.13	N/A	60.80 N	3000.00	(a)	NO	B
NA	ALKALINITY, TOTAL (AS CACO3)	5000.0000	U	86000.000		µg/L	00MW0587A, -112.63	76 : 95	5000 -- 5000	86000.00	N/A	N/A	N/A		NO	G
7429-90-5	ALUMINUM	5.8000	U	474.000		µg/L	00MW0584C, 32.82	5 : 56	16.6 -- 5.8	474.00	N/A	50.00 N1	50.00	(a)	YES	C
7429-90-5	ALUMINUM (TOTAL)	16.6000	U	1470.000		µg/L	00MW0591A, -201.06	19 : 115	16.6 -- 16.6	1470.00	N/A	50.00 N1	50.00	(a)	YES	C
7440-38-2	ARSENIC	1.0000	U	3.100	J	µg/L	00MW0583A, -244.83	7 : 56	1 -- 1.8	3.10	N/A	0.05 C	5.00	(a)	YES	C
7440-38-2	ARSENIC (TOTAL)	1.0000	UJ	6.400		µg/L	00MW0606B, -124.29	10 : 115	1 -- 2.6	6.40	N/A	0.05 C	5.00	(a)	YES	C
7440-39-3	BARIUM	1.8000	U	91.800		µg/L	00MW0588B, 22.96	53 : 56	0 2 -- 1.8	91.80	N/A	255.00 N	2000.00	(a)	NO	B
7440-39-3	BARIUM (TOTAL)	1.8000	U	101.000		µg/L	00MW0588B, 22.96	100 : 115	0.2 -- 1.8	101.00	N/A	255.00 N	2000.00	(a)	NO	B
71-43-2	BENZENE	0.0990	U	5.800	J	µg/L	03MW0061, -144.72	1 : 234	0.099 -- 2.5	5.80	N/A	0.35 C	5.00	(a)	NO	A
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	0.8000	U	2.200	J	µg/L	00MW0581B, -42.2	9 : 31	0.8 -- 0.8	2.20	N/A	4.80 C	6.00	(a)	NO	B
7440-42-8	BORON	22.8000	U	311.000		µg/L	00MW0589A, -197.69	46 : 70	2.2 -- 22.8	311.00	N/A	328.00 N	N/A		NO	B
7440-42-8	BORON (TOTAL)	29.8000	U	335.000		µg/L	00MW0581B, -42.2	30 : 39	14.4 -- 29.8	335.00	N/A	328.00 N	N/A		YES	C
24959-67-9	BROMIDE	3.2000	U	120.000	J	µg/L	00MW0581A, -187	30 : 58	0.0032 -- 0.05	120.00	N/A	N/A	N/A		NO	H
7440-43-9	CADMIUM	0.1800	U	1.200		µg/L	MAMW0196D, 0	7 : 56	0.18 -- 0.3	1.20	N/A	1.83 N	5.00	(a)	NO	B
7440-43-9	CADMIUM (TOTAL)	0.1800	U	1.800		µg/L	00MW0583D, 29.96	6 : 115	0.18 -- 0.3	1.80	N/A	1.83 N	5.00	(a)	NO	A,B
7440-70-2	CALCIUM	2590.0000		34300.000		µg/L	MAMW0296I, -56.8	56 : 56	15.6 -- 15.6	34300.00	N/A	N/A	N/A		NO	F
7440-70-2	CALCIUM (TOTAL)	1900.0000	J	33350.000		µg/L	00MW0587A, -112.63	115 : 115	15.6 -- 71.9	33350.00	N/A	N/A	N/A		NO	F
16887-00-6	CHLORIDE (AS CL)	7400.0000		25600.000		µg/L	95MW0206A, -135.69	68 : 68	0.056 -- 0 115	25600.00	N/A	250000.00 N1	250000.00	(a)	NO	B
67-66-3	CHLOROFORM	0.0800	U	0.530	J	µg/L	03MW2412B, -94.6	1 : 197	0.08 -- 0.11	0.53	N/A	0.06 N	5.00	(a)	NO	A
74-87-3	CHLOROMETHANE	0.1000	U	1.230		µg/L	ECMWAMP05B, 15.53	1 : 200	0.1 -- 0.28	1.23	N/A	1.51 C	N/A		NO	A,B
18540-29-9	CHROMIUM (TOTAL)	0.4000	U	8.890		µg/L	00MW0581B, -42.2	19 : 131	0.4 -- 0.4	8.89	N/A	11.00 N	100.00	(a)	NO	B
156-59-2	CIS-1,2-DICHLOROETHENE	0.0800	U	9.000		µg/L	03MP0091A, -162.57	14 : 234	0.08 -- 0.24	9.00	N/A	6.08 N	70.00	(a)	YES	C
7440-48-4	COBALT	0.3000	U	8.600		µg/L	00MW0589B, -95.44	12 : 56	0.3 -- 0.3	8 60	N/A	219.00 N	N/A		NO	B
7440-48-4	COBALT (TOTAL)	0.4000	U	7.100		µg/L	03MW2622A, -222.28	20 : 115	0.4 -- 0.69	7.10	N/A	219.00 N	N/A		NO	B
7440-50-8	COPPER	0.5000	UJ	2.600	J	µg/L	00MW0582A, -121.29	2 : 55	0.5 -- 0.8	2.60	N/A	136.00 N	1300.00	(a)	NO	A,B
7440-50-8	COPPER (TOTAL)	0.6000	UJ	10.300	J	µg/L	00MW0581B, -42.2	6 : 115	0.6 -- 3.4	10.30	N/A	136.00 N	1300.00	(a)	NO	A,B
7782-41-4	FLUORIDE	12.0000	U	63.000	J	µg/L	00MW0565, -58.15	1 : 2	0.012 -- 0.012	63.00	N/A	220.00 N	4000.00	(a)	NO	B
7439-89-6	IRON	5.3000	U	20800.000		µg/L	00MW0584C, 32.82	61 : 85	22.3 -- 5.3	20800.00	N/A	300.00 N1	300.00	(a)	NO	F
7439-89-6	IRON (TOTAL)	5.3000	U	19500.000		µg/L	00MW0584C, 32.82	64 : 116	10 -- 5.3	19500.00	N/A	300.00 N1	300.00	(a)	NO	F
439-92-1	LEAD	0.8000	UJ	17.000		µg/L	MAMW0196D, 0	13 : 61	0.8 -- 1	17.00	N/A	15.00 N1	15.00	(a)	YES	C
439-92-1	LEAD (TOTAL)	0.6000	UJ	30.600		µg/L	00MW0583D, 29.96	11 : 115	0.6 -- 1	30.60	N/A	15.00 N1	15.00	(a)	YES	C
1330-20-7	M,P-XYLENE (SUM OF ISOMERS)	0.4060	U	0.570	J	µg/L	95BH1219, 50	2 : 26	0.406 -- 0.406	0.57	N/A	143.00 N	10000.00	(a)	NO	B
7439-95-4	MAGNESIUM	739.0000		8140.000		µg/L	03MW2620A, -164.17	56 : 56	23 -- 50.7	8140.00	N/A	N/A	N/A		NO	F
7439-95-4	MAGNESIUM (TOTAL)	800.0000		8310.000		µg/L	03MW2620A, -164.17	115 : 115	23 -- 50.7	8310.00	N/A	N/A	N/A		NO	F
7439-96-5	MANGANESE	0.4100	U	2960.000		µg/L	95BH1219, 20	75 : 85	0.41 -- 1	2960.00	N/A	50.00 N1	50.00	(a)	YES	C
7439-96-5	MANGANESE (TOTAL)	0.5200	U	1570.000		µg/L	03MW2622A, -222.28	79 : 116	0.21 -- 0.52	1570.00	N/A	50.00 N1	50.00	(a)	YES	C
7439-97-6	MERCURY (TOTAL)	0.0500	U	0.078	J	µg/L	00MW0589C, 2.7	16 : 79	0.05 -- 0.05	0.08	N/A	1.10 N	2.00	(a)	NO	B
75-09-2	METHYLENE CHLORIDE	0.0800	U	23.000	J	µg/L	03MP0091C, -85.57	6 : 209	0.08 -- 3.2	23.00	N/A	4.28 C	5.00	(a)	NO	A
1634-04-4	METHYL-TERT-BUTYL-ETHER (MTBE)	0.0900	U	2.400		µg/L	MAMW0520A, 0	16 : 209	0.09 -- 0.1	2.40	N/A	2.00 N	20.00	(a)	YES	C
7440-02-0	NICKEL	0.6000	U	4.450	J	µg/L	00MW0587A, -112.63	19 : 56	0.6 -- 1	4.45	N/A	73.00 N	100.00	(a)	NO	B
7440-02-0	NICKEL (TOTAL)	0.9000	U	11.600	J	µg/L	00MW0581B, -42.2	26 : 113	0.9 -- 1	11.60	N/A	73.00 N	100.00	(a)	NO	B
7727-37-9	NITROGEN	8.7000	U	3240.000		µg/L	95BH1219, 10	63 : 65	8.7 -- 8.7	3240.00	N/A	N/A	N/A		NO	G
7664-41-7	NITROGEN, AMMONIA (AS N)	0.9000	U	2870.000		µg/L	95BH1215, 9.5	39 : 82	0.9 -- 5	2870.00	N/A	N/A	N/A		NO	G
14797-55-8	NITROGEN, NITRATE (AS N)	2.5000	U	2050.000		µg/L	95BH1215, 19.5	97 : 117	1.8 -- 2.5	2050.00	N/A	10000.00 N1	10000.00	(a)	NO	B
NA	NITROGEN, NITRATE-NITRITE	220.0000		620.000		µg/L	00MW0565, -58.15	3 : 3	0.0053 -- 0.01	620.00	N/A	10000.00 N1	10000.00	(a)	NO	B
14797-65-0	NITROGEN, NITRITE	0.2000	U	70.000	J	µg/L	03MW2618B, -70.77	24 : 93	0.0091 -- 0.2	70.00	N/A	1000.00 N1	1000.00	(a)	NO	B
108-95-2	PHENOL	0.5000	U	13.000		µg/L	00MW0583A, -244.83	1 : 31	0.5 -- 0.5	13.00	N/A	2190.00 N	N/A		NO	A,B
7723-14-0	PHOSPHORUS, DISSOLVED (AS P)	1.7000	J	383.000		µg/L	95BH1215, 2.5	13 : 14	1.5 -- 15	383.00	N/A	N/A	N/A		NO	G

Table 2-2
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Current CS-10 Leading Edge Groundwater

Scenario Timeframe:	Current
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located upgradient of Ashumet Pond, between Ashumet and Johns ponds, and downgradient of Johns Pond - and not within TCE plume)

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
7723-14-0	PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE	92.0000	U	400.000		µg/L	03MP0092E, -3.94	2 : 5	0.03 -- 0.092	400.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL (AS P)	1.5000	U	202.000		µg/L	95MW0206A, -135.69	51 : 56	0.009 -- 1.5	202.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL HYDROLYZABLE (AS P)	5.7000		351.000		µg/L	95BH1215, 2.5	11 : 11	0.6 -- 6	351.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL PO4 (AS P)	0.6000	U	130.000	J	µg/L	00MW0580D, 20.06	56 : 103	0.026 -- 0.6	130.00	N/A	N/A	N/A		NO	G
7440-09-7	POTASSIUM	423.0000	U	5785.000		µg/L	03MW2617A, -156.45	41 : 56	24.5 -- 423	5785.00	N/A	N/A	N/A		NO	F
7440-09-7	POTASSIUM (TOTAL)	612.0000	U	6180.000		µg/L	03MW2618A, -167.27	99 : 115	24.5 -- 612	6180.00	N/A	N/A	N/A		NO	F
7782-49-2	SELENIUM (TOTAL)	1.4000	U	3.175	J	µg/L	MAMW0520B, 0	2 : 115	1.4 -- 4.1	3.18	N/A	18.30 N	50.00	(a)	NO	A,B
7440-21-3	SILICON	380.0000	J	9340.000		µg/L	00MW0583A, -244.83	32 : 32	30.8 -- 46.9	9340.00	N/A	N/A	N/A		NO	H
7440-21-3	SILICON (TOTAL)	1770.0000		9420.000		µg/L	00MW0583A, -244.83	4 : 4	46.9 -- 46.9	9420.00	N/A	N/A	N/A		NO	G
7440-22-4	SILVER	0.4000	U	1.100	J	µg/L	00MW0583A, -244.83	2 : 56	0.4 -- 0.5	1.10	N/A	18.30 N	100.00	(a)	NO	A,B
7440-22-4	SILVER (TOTAL)	0.4000	U	0.630	J	µg/L	00MW0583B, -125.04	1 : 87	0.4 -- 0.5	0.63	N/A	18.30 N	100.00	(a)	NO	A,B
7440-23-5	SODIUM	7250.0000		31700.000		µg/L	95MW0206A, -135.69	56 : 56	276 -- 28.4	31700.00	N/A	20000.00 N1	20000.00	(a)	NO	F
7440-23-5	SODIUM (TOTAL)	6590.0000		23200.000		µg/L	00MW0589A, -197.69	115 : 115	295 -- 357	23200.00	N/A	20000.00 N1	20000.00	(a)	NO	F
14808-79-8	SULFATE (AS SO4)	1500.0000		980000.000		µg/L	03MP0092E, -3.94	68 : 68	0.26 -- 5.8	980000.00	N/A	250000.00 N1	250000.00	(a)	NO	G,H
18496-25-8	SULFIDE	530.0000	U	1170.000		µg/L	95BH1215, 39.5	3 : 14	0.53 -- 0.53	1170.00	N/A	N/A	N/A		NO	G,H
NA	SUSPENDED SOLIDS (RESIDUE, NON-FILT	10000.0000		10000.000		µg/L	03MW0064, -160	1 : 1	3.6 -- 3.6	10000.00	N/A	N/A	N/A		NO	G
127-18-4	TETRACHLOROETHENE(PCE)	0.1000	U	7.560		µg/L	03MP0091A, -162.57	14 : 234	0.1 -- 0.22	7.56	N/A	1.08 C	5.00	(a)	YES	C
7440-28-0	THALLIUM	0.7000	U	4.300	J	µg/L	03MW2624A, -237.16	1 : 54	0.7 -- 0.7	4.30	N/A	0.24 N	2.00	(a)	NO	A
108-88-3	TOLUENE	0.0900	U	1.700		µg/L	00MW0607A, -133.24	11 : 232	0.09 -- 0.09	1.70	N/A	72.30 N	1000.00	(a)	NO	A,B
NA	TOTAL DISSOLVED SOLIDS	75000.0000		75000.000		µg/L	03MW0064, -160	1 : 1	4.4 -- 4.4	75000.00	N/A	500000.00 N1	500000.00	(a)	NO	B
79-01-6	TRICHLOROETHENE(TCE)	0.0900	U	760.000		µg/L	03MP0091A, -162.57	62 : 234	0.09 -- 3.6	760.00	N/A	1.64 C	5.00	(a)	YES	C
7440-62-2	VANADIUM	0.5000	U	1.100	J	µg/L	MAMW0396S, 32.2	1 : 54	0.5 -- 0.5	1.10	N/A	25.60 N	N/A		NO	A,B
7440-62-2	VANADIUM (TOTAL)	0.5000	U	7.900	J	µg/L	MAMW0520A, 0	12 : 115	0.5 -- 0.8	7.90	N/A	25.60 N	N/A		NO	B
7440-66-6	ZINC	0.3300	UJ	70.000		µg/L	MAMW0196D, 0	25 : 56	0.33 -- 0.8	70.00	N/A	1090.00 N	5000.00	(a)	NO	B
7440-66-6	ZINC (TOTAL)	0.3300	UJ	66.000	J	µg/L	00MW0588B, 22.96	39 : 115	0.33 -- 0.8	66.00	N/A	1090.00 N	5000.00	(a)	NO	B

Note. This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value.
N/A = Not Available.
U = Not Detected.
µg/L = micrograms per liter.
(1 Minimum/maximum detected concentration.
(2 Maximum detected concentration used as screening value.
(3 Lowest water screening value available:
C - EPA Region 9 PRG, November 2000. Residential Tap Water: Carcinogens.
N - EPA Region 9 PRG, November 2000. Residential Tap Water: Non-carcinogens; based on a hazard quotient of 0.1.
N1 - EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.
(a) EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.

(4) Rationale Codes
Reasons for elimination or selection
A - Frequency of detection is less than or equal to 5%.
B - Maximum detected concentration is less than water screening value.
C - Maximum detected concentration exceeds water screening value.
D - Screening values are not available.
E - Compound is retained because it is site-related.
F - Essential Nutrient.
G - General Chemistry Parameter.
H - Lack of toxicity criteria.

Table 2-3
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Future CS-10 Leading Edge Groundwater

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located upgradient of Ashumet Pond, underneath Ashumet Pond, between Ashumet and Johns ponds, and downgradient of Johns Pond - and not within TCE plume)

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
71-55-6	1,1,1-TRICHLOROETHANE	0.09	U	1.80		µg/L	00BH0711, 0	2 : 348	0.09 -- 0.328	1.80	N/A	54.10 N	200.00	(a)	NO	A,B
75-34-3	1,1-DICHLOROETHANE	0.07	U	0.93	J	µg/L	00MW0582A, -121.29	1 : 226	0.07 -- 0.07	0.93	N/A	81.10 N	N/A		NO	A,B
75-35-4	1,1-DICHLOROETHENE	0.09	U	1.80		µg/L	00BH0711, 0	2 : 348	0.09 -- 0.532	1.80	N/A	0.05 C	7.00	(a)	NO	A
106-93-4	1,2-DIBROMOETHANE (EDB)	0.00	U	0.04		µg/L	03MW2617B, -41.45	10 : 289	0.0024 -- 0.0051	0.04	N/A	0.00076 C	0.02	(a)	YES	E
106-46-7	1,4-DICHLOROBENZENE	0.10	U	0.84	J	µg/L	00MW0589A, -197.69	5 : 225	0.097 -- 0.097	0.84	N/A	0.50 C	5.00	(a)	NO	A
106-46-7	1,4-DICHLOROBENZENE	0.10	U	0.84	J	µg/L	00MW0589A, -197.69	5 : 225	0.097 -- 0.097	0.84	N/A	0.50 C	5.00	(a)	NO	A
106-44-5	4-METHYLPHENOL (P-CRESOL)	0.51	U	1.10	J	µg/L	00MW0584C, 32.82	1 : 31	0.51 -- 0.51	1.10	N/A	18.30 N	N/A		NO	A,B
67-64-1	ACETONE	0.71	U	7.13	J	µg/L	ECMWAMP05A, -44.47	1 : 4	0.71 -- 2.82	7.13	N/A	60.80 N	3000.00	(a)	NO	B
NA	ALKALINITY, TOTAL (AS CACO3)	4490.00	U	86000.00		µg/L	00MW0587A, -112.63	121 : 153	4.49 -- 5	86000.00	N/A	N/A	N/A		NO	G
7429-90-5	ALUMINUM	5.80	U	474.00		µg/L	00MW0584C, 32.82	5 : 67	5.8 -- 16.6	474.00	N/A	50.00 N1	50.00	(a)	YES	C
7429-90-5	ALUMINUM (TOTAL)	16.60	U	1470.00		µg/L	00MW0591A, -201.06	19 : 115	16.6 -- 16.6	1470.00	N/A	50.00 N1	50.00	(a)	YES	C
7440-36-0	ANTIMONY (TOTAL)	1.20	U	1.50	J	µg/L	00MW0587A, -112.63	1 : 66	1.2 -- 1.5	1.50	N/A	1.46 N	6.00	(a)	NO	A
7440-38-2	ARSENIC	1.00	U	3.10	J	µg/L	00MW0583A, -244.83	7 : 67	1 -- 1.8	3.10	N/A	0.05 C	5.00	(a)	YES	C
7440-38-2	ARSENIC (TOTAL)	1.00	UJ	6.40		µg/L	00MW0606B, -124.29	9 : 115	1 -- 2.6	6.40	N/A	0.05 C	5.00	(a)	YES	C
7440-39-3	BARIUM	1.80	U	91.80		µg/L	00MW0588B, 22.96	64 : 67	0.2 -- 1.8	91.80	N/A	255.00 N	2000.00	(a)	NO	B
7440-39-3	BARIUM (TOTAL)	1.80	U	101.00		µg/L	00MW0588B, 22.96	100 : 115	0.2 -- 1.8	101.00	N/A	255.00 N	2000.00	(a)	NO	B
71-43-2	BENZENE	0.10	U	5.80	J	µg/L	03MW0061, -144.72	1 : 348	0.099 -- 2.5	5.80	N/A	0.35 C	5.00	(a)	NO	A
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	0.80	U	2.20	J	µg/L	00MW0581B, -42.2	9 : 31	0.8 -- 0.8	2.20	N/A	4.80 C	6.00	(a)	NO	B
7440-42-8	BORON	22.80	U	311.00		µg/L	00MW0589A, -197.69	69 : 102	2.7 -- 22.8	311.00	N/A	328.00 N	N/A		NO	B
7440-42-8	BORON (TOTAL)	29.80	U	335.00		µg/L	00MW0581B, -42.2	32 : 41	14.4 -- 29.8	335.00	N/A	328.00 N	N/A		YES	C
24959-67-9	BROMIDE	3.20	U	120.00	J	µg/L	00MW0581A, -187	30 : 58	0.0032 -- 0.05	120.00	N/A	N/A	N/A		NO	H
7440-43-9	CADMIUM	0.18	U	1.20		µg/L	MAMW0196D, 0	7 : 67	0.18 -- 0.3	1.20	N/A	1.83 N	5.00	(a)	NO	B
7440-43-9	CADMIUM (TOTAL)	0.18	U	1.80		µg/L	00MW0583D, 29.96	7 : 115	0.18 -- 0.3	1.80	N/A	1.83 N	5.00	(a)	NO	B
7440-70-2	CALCIUM	2020.00	J	34300.00		µg/L	MAMW0296I, -56.8	67 : 67	15.6 -- 19.2	34300.00	N/A	N/A	N/A		NO	F
7440-70-2	CALCIUM (TOTAL)	1900.00	J	33350.00		µg/L	00MW0587A, -112.63	115 : 115	15.6 -- 71.9	33350.00	N/A	N/A	N/A		NO	F
56-23-5	CARBON TETRACHLORIDE	0.08	U	0.50		µg/L	00BH0711, 0	2 : 337	0.08 -- 0.08	0.50	N/A	0.17 C	5.00	(a)	NO	A
16887-00-6	CHLORIDE (AS CL)	7000.00		30200.00		µg/L	95MW1223C, 30.8	82 : 82	0.056 -- 0.85	30200.00	N/A	250000.00 N1	250000.00	(a)	NO	B
67-66-3	CHLOROFORM	0.08	U	0.53	J	µg/L	03MW2412B, -94.6	1 : 222	0.08 -- 0.11	0.53	N/A	0.06 N	5.00	(a)	NO	A
74-87-3	CHLOROMETHANE	0.10	U	1.23		µg/L	ECMWAMP05B, 15.53	1 : 225	0.1 -- 0.28	1.23	N/A	1.51 C	N/A		NO	A,B
18540-29-9	CHROMIUM (TOTAL)	0.40	U	8.89		µg/L	MAMW0520B, 0	20 : 142	0.4 -- 0.4	8.89	N/A	11.00 N	100.00	(a)	NO	B
156-59-2	CIS-1,2-DICHLOROETHENE	0.08	U	9.00	J	µg/L	03MP0091A, -162.57	24 : 348	0.08 -- 4.3	9.00	N/A	6.08 N	70.00	(a)	YES	C
7440-48-4	COBALT	0.30	U	8.60		µg/L	00MW0589B, -95.44	13 : 67	0.3 -- 0.3	8.60	N/A	219.00 N	N/A		NO	B
7440-48-4	COBALT (TOTAL)	0.40	U	7.10		µg/L	03MW2622A, -222.28	20 : 115	0.4 -- 0.69	7.10	N/A	219.00 N	N/A		NO	B
7440-50-8	COPPER	0.50	UJ	2.60	J	µg/L	00MW0582A, -121.29	2 : 66	0.5 -- 0.8	2.60	N/A	136.00 N	1300.00	(a)	NO	A,B
7440-50-8	COPPER (TOTAL)	0.60	UJ	10.30	J	µg/L	00MW0581B, -42.2	6 : 115	0.6 -- 3.4	10.30	N/A	136.00 N	1300.00	(a)	NO	A,B
100-41-4	ETHYLBENZENE	0.10	U	0.67	J	µg/L	00BH0704, 0	2 : 337	0.096 -- 0.282	0.67	N/A	134.00 N	700.00	(a)	NO	A,B
7782-41-4	FLUORIDE	12.00	U	63.00	J	µg/L	00MW0565, -58.15	1 : 2	0.012 -- 0.012	63.00	N/A	220.00 N	4000.00	(a)	NO	B
NA	HARDNESS (AS CACO3)	16100.00		34000.00		µg/L	ECMWAMP07C, 10.4	12 : 12	3.4 -- 3.4	34000.00	N/A	N/A	N/A		NO	G
7439-89-6	IRON	5.30	U	20800.00		µg/L	00MW0584C, 32.82	78 : 104	22.3 -- 5.3	20800.00	N/A	300.00 N1	300.00	(a)	NO	F
7439-89-6	IRON (TOTAL)	5.30	U	19500.00		µg/L	00MW0584C, 32.82	64 : 116	10 -- 5.3	19500.00	N/A	300.00 N1	300.00	(a)	NO	F
439-92-1	LEAD	0.80	UJ	17.00		µg/L	MAMW0196D, 0	13 : 72	0.8 -- 1	17.00	N/A	15.00 N1	15.00	(a)	YES	C
439-92-1	LEAD (TOTAL)	0.60	UJ	30.60		µg/L	00MW0583D, 29.96	12 : 115	0.6 -- 1	30.60	N/A	15.00 N1	15.00	(a)	YES	C
1330-20-7	M,P-XYLENE (SUM OF ISOMERS)	0.41	U	1.62		µg/L	00BH0702, 0	10 : 115	0.406 -- 0.406	1.62	N/A	143.00 N	10000.00	(a)	NO	B
7439-95-4	MAGNESIUM	739.00		8140.00		µg/L	03MW2620A, -164.17	67 : 67	23 -- 50.7	8140.00	N/A	N/A	N/A		NO	F
7439-95-4	MAGNESIUM (TOTAL)	800.00		8310.00		µg/L	03MW2620A, -164.17	115 : 115	23 -- 50.7	8310.00	N/A	N/A	N/A		NO	F
7439-96-5	MANGANESE	0.41	U	2960.00		µg/L	95BH1219, 20	89 : 104	0.41 -- 1	2960.00	N/A	50.00 N1	50.00	(a)	YES	C
7439-96-5	MANGANESE (TOTAL)	0.52	U	1570.00		µg/L	03MW2622A, -222.28	79 : 116	0.21 -- 0.52	1570.00	N/A	50.00 N1	50.00	(a)	YES	C
7439-97-6	MERCURY (TOTAL)	0.05	U	0.08	J	µg/L	00MW0589C, 2.7	16 : 79	0.05 -- 0.05	0.08	N/A	1.10 N	2.00	(a)	NO	B
75-09-2	METHYLENE CHLORIDE	0.08	U	23.00	J	µg/L	03MP0091C, -85.57	6 : 234	0.08 -- 3.2	23.00	N/A	4.28 C	5.00	(a)	NO	A

Table 2-3
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Future CS-10 Leading Edge Groundwater

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located upgradient of Ashumet Pond, underneath Ashumet Pond, between Ashumet and Johns ponds, and downgradient of Johns Pond - and not within TCE plume)

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
1634-04-4	METHYL-TERT-BUTYL-ETHER (MTBE)	0.09	U	2.40		µg/L	MAMW0520A, 0	16 : 234	0.09 -- 0.1	2.40	N/A	2.00 N	20.00	(a)	YES	C
7440-02-0	NICKEL	0.60	U	86.15		µg/L	95MW1223A, -29.2	29 : 67	0.6 -- 1.4	86.15	N/A	73.00 N	100.00	(a)	YES	C
7440-02-0	NICKEL (TOTAL)	0.90	U	11.60	J	µg/L	00MW0581B, -42.2	28 : 113	0.9 -- 1	11.60	N/A	73.00 N	100.00	(a)	NO	B
7727-37-9	NITROGEN	8.70	U	4478.26		µg/L	95BH1219, 10	120 : 123	8.7 -- 87	4478.26	N/A	N/A	N/A		NO	G
7664-41-7	NITROGEN, AMMONIA (AS N)	0.90	U	2870.00		µg/L	95BH1215, 9.5	66 : 140	0.9 -- 5	2870.00	N/A	N/A	N/A		NO	G
14797-55-8	NITROGEN, NITRATE (AS N)	0.90	U	2050.00		µg/L	95BH1215, 19.5	150 : 175	0.9 -- 9	2050.00	N/A	10000.00 N1	10000.00	(a)	NO	B
NA	NITROGEN, NITRATE-NITRITE	220.00		620.00		µg/L	00MW0565, -58.15	3 : 3	0.0053 -- 0.01	620.00	N/A	10000.00 N1	10000.00	(a)	NO	B
14797-65-0	NITROGEN, NITRITE	0.20	U	70.00	J	µg/L	03MW2618B, -70.77	41 : 129	0.0091 -- 0.2	70.00	N/A	1000.00 N1	1000.00	(a)	NO	B
95-47-6	O-XYLENE (1,2-DIMETHYLBENZENE)	0.28	U	1.16		µg/L	00BH0702, 0	3 : 115	0.28 -- 0.289	1.16	N/A	143.00 N	10000.00	(a)	NO	A,B
108-95-2	PHENOL	0.50	U	13.00		µg/L	00MW0583A, -244.83	1 : 31	0.5 -- 0.5	13.00	N/A	2190.00 N	N/A		NO	A,B
7723-14-0	PHOSPHORUS, DISSOLVED (AS P)	1.50	U	405.40		µg/L	00BH0704, 0	44 : 46	1.5 -- 30	405.40	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE	92.00	U	400.00		µg/L	03MP0092E, -3.94	2 : 5	0.03 -- 0.092	400.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL (AS P)	1.50	U	202.00		µg/L	95MW0206A, -135.69	89 : 94	0.009 -- 1.5	202.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL HYDROLYZABLE (AS)	0.60	U	351.00		µg/L	95BH1215, 2.5	28 : 30	0.6 -- 6	351.00	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL PO4 (AS P)	0.60	U	130.00	J	µg/L	00MW0580D, 20.06	95 : 142	0.026 -- 0.6	130.00	N/A	N/A	N/A		NO	G
7440-09-7	POTASSIUM	423.00	U	5785.00		µg/L	03MW2617A, -156.45	52 : 67	24.5 -- 423	5785.00	N/A	N/A	N/A		NO	F
7440-09-7	POTASSIUM (TOTAL)	612.00	U	6180.00		µg/L	03MW2618A, -167.27	99 : 115	24.5 -- 612	6180.00	N/A	N/A	N/A		NO	F
7782-49-2	SELENIUM (TOTAL)	1.40	U	3.18	J	µg/L	MAMW0520B, 0	2 : 115	1.4 -- 4.1	3.18	N/A	18.30 N	50.00	(a)	NO	A,B
7440-21-3	SILICON	380.00	J	9340.00		µg/L	00MW0583A, -244.83	43 : 43	30.8 -- 46.9	9340.00	N/A	N/A	N/A		NO	H
7440-21-3	SILICON (TOTAL)	1770.00		9420.00		µg/L	00MW0583A, -244.83	4 : 4	46.9 -- 46.9	9420.00	N/A	N/A	N/A		NO	G
7440-22-4	SILVER	0.40	U	1.10	J	µg/L	00MW0583A, -244.83	2 : 67	0.4 -- 0.5	1.10	N/A	18.30 N	100.00	(a)	NO	A,B
7440-22-4	SILVER (TOTAL)	0.40	U	0.63	J	µg/L	00MW0583B, -125.04	1 : 87	0.4 -- 0.5	0.63	N/A	18.30 N	100.00	(a)	NO	A,B
7440-23-5	SODIUM	7250.00		31700.00		µg/L	95MW0206A, -135.69	67 : 67	276 -- 28.4	31700.00	N/A	20000.00 N1	20000.00	(a)	NO	F
7440-23-5	SODIUM (TOTAL)	6590.00		23200.00		µg/L	00MW0589A, -197.69	115 : 115	295 -- 357	23200.00	N/A	20000.00 N1	20000.00	(a)	NO	F
14808-79-8	SULFATE (AS SO4)	1500.00		980000.00		µg/L	03MP0092E, -3.94	82 : 82	0.26 -- 5.8	980000.00	N/A	250000.00 N1	250000.00	(a)	NO	G,H
18496-25-8	SULFIDE	530.00	U	1170.00		µg/L	95BH1215, 39.5	3 : 22	0.53 -- 0.53	1170.00	N/A	N/A	N/A		NO	G,H
NA	SUSPENDED SOLIDS (RESIDUE, NON-FILT	10000.00		10000.00		µg/L	03MW0064, -160	1 : 1	3.6 -- 3.6	10000.00	N/A	N/A	N/A		NO	G
127-18-4	TETRACHLOROETHENE(PCE)	0.10	U	7.56	J	µg/L	03MP0091A, -162.57	23 : 348	0.1 -- 5.76	7.56	N/A	1.08 C	5.00	(a)	YES	C
7440-28-0	THALLIUM	0.70	U	4.30		µg/L	03MW2624A, -237.16	1 : 65	0.7 -- 0.7	4.30	N/A	0.24 N	2.00	(a)	NO	A
108-88-3	TOLUENE	0.09	U	1.80		µg/L	00MW0607A, -133.24	34 : 348	0.09 -- 0.197	1.80	N/A	72.30 N	1000.00	(a)	NO	B
NA	TOTAL DISSOLVED SOLIDS	75000.00		75000.00		µg/L	03MW0064, -160	1 : 1	4.4 -- 4.4	75000.00	N/A	500000.00 N1	500000.00	(a)	NO	B
79-01-6	TRICHLOROETHENE(TCE)	0.09	U	856.70		µg/L	95BH1222, 0	88 : 348	0.09 -- 6.44	856.70	N/A	1.64 C	5.00	(a)	YES	C
7440-62-2	VANADIUM	0.50	U	1.10	J	µg/L	MAMW0396S, 32.2	1 : 65	0.5 -- 0.5	1.10	N/A	25.60 N	N/A		NO	A,B
7440-62-2	VANADIUM (TOTAL)	0.50	U	7.90	J	µg/L	MAMW0520A, 0	12 : 115	0.5 -- 0.8	7.90	N/A	25.60 N	N/A		NO	B
7440-66-6	ZINC	0.33	UJ	70.00		µg/L	MAMW0196D, 0	26 : 67	0.33 -- 0.8	70.00	N/A	1090.00 N	5000.00	(a)	NO	B
7440-66-6	ZINC (TOTAL)	0.33	UJ	66.00	J	µg/L	00MW0588B, 22.96	39 : 115	0.33 -- 0.8	66.00	N/A	1090.00 N	5000.00	(a)	NO	B

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value.
N/A = Not Available
U = Not Detected.
µg/L = micrograms per liter.
(1) Minimum/maximum detected concentration.
(2) Maximum detected concentration used as screening value.
(3) Lowest water screening value available:
C - EPA Region 9 PRG, November 2000. Residential Tap Water: Carcinogens.
N - EPA Region 9 PRG, November 2000. Residential Tap Water: Non-carcinogens; based on a hazard quotient of 0.1.
N1 - EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.
(a) EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.

(4) Rationale Codes
Reasons for elimination or selection
A - Frequency of detection is less than or equal to 5%.
B - Maximum detected concentration is less than water screening value.
C - Maximum detected concentration exceeds water screening value.
D - Screening values are not available.
E - Compound is retained because it is site-related.
F - Essential Nutrient.
G - General Chemistry Parameter.
H - Lack of toxicity criteria.

Table 2-4
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Ashumet and Johns Pond Surface Water

Scenario Timeframe:	Current and Future
Medium:	Surface Water
Exposure Medium:	Surface Water
Exposure Point:	Ashumet Pond and Johns Pond

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Cocentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Source	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
67-64-1	ACETONE	7.68	J	11.30	J	µg/L	ECAMP07, 31	2 : 2	2.93 -- 2.93	11.30	N/A	60.8 N	3000	(a)	NO	B
NA	ALKALINITY, TOTAL (AS CACO3)	5200.00	U	41400.00		µg/L	ECAMP52, 45	116 : 193	2.2 -- 5.2	10851.71	N/A	N/A	N/A		NO	G
7429-90-5	ALUMINUM	20.70	U	47.30	J	µg/L	ECAMP15, 3	1 : 70	20.7 -- 28.6	14.55	N/A	50 N1	50	(a)	NO	A,B
7440-36-0	ANTIMONY (TOTAL)	1.60	U	1.80	J	µg/L	ECJNP05, 3	1 : 11	1.6 -- 1.6	1.23	N/A	1.46 N	6	(a)	YES	C
7440-39-3	BARIUM	1.83	U	61.10	J	µg/L	ECAMP02, 62	63 : 70	0.5 -- 1.83	9.83	N/A	255 N	1000	(b)	NO	B
7440-39-3	BARIUM (TOTAL)	1.59	J	22.70		µg/L	ECAMP07, 31	11 : 12	0.3 -- 0.3	13.13	N/A	255 N	1000	(b)	NO	B
7440-41-7	BERYLLIUM	0.10	U	0.76	J	µg/L	ECAMP02, 60	4 : 70	0.1 -- 0.7	0.37	N/A	4 N1	4	(a)	NO	B
7440-41-7	BERYLLIUM (TOTAL)	0.10	U	0.21	J	µg/L	ECAMP05, 3	1 : 12	0.1 -- 0.1	0.14	N/A	4 N1	4	(a)	NO	B
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	1.00	U	25.90		µg/L	ECAMP07, 31	2 : 10	1 -- 4.39	25.90	N/A	1.8 N2	1.8	(b)	YES	C
7440-42-8	BORON	43.30	U	120.00		µg/L	ECAMP16, 17	63 : 73	0.7 -- 43.3	63.14	N/A	328 N	N/A		NO	B
7440-42-8	BORON (TOTAL)	41.30	U	63.80		µg/L	ECAMP04, 30	3 : 12	0.7 -- 41.3	45.97	N/A	328 N	N/A		NO	B
24959-67-9	BROMIDE	3.20	U	63.00	J	µg/L	ECAMP06, 3	7 : 12	0.0032 -- 0.022	44.19	N/A	N/A	N/A		NO	H
7440-70-2	CALCIUM	1830.00	U	4100.00	J	µg/L	ECAMP02, 50	69 : 70	19.2 -- 1830	2364.37	N/A	N/A	N/A		NO	F
7440-70-2	CALCIUM (TOTAL)	1520.00		2920.00		µg/L	ECAMP07, 31	12 : 12	28.7 -- 68.6	2490.37	N/A	N/A	N/A		NO	F
16887-00-6	CHLORIDE (AS CL)	14700.00	U	16800.00		µg/L	ECAMP04, 10	74 : 75	0.85 -- 14.7	14338.32	N/A	250000 N1	250000	(a)	NO	B
75-00-3	CHLOROETHANE	0.08	U	1.20		µg/L	28JNP0114, 0.5	1 : 35	0.08 -- 0.08	0.10	N/A	N/A	N/A		NO	H
18540-29-9	CHROMIUM (TOTAL)	0.30	U	3.02	J	µg/L	ECAMP04, 20	20 : 75	0.3 -- 0.7	0.63	N/A	11 N	100	(a)	NO	B
7440-50-8	COPPER	0.70	UJ	26.30		µg/L	ECAMP51, 20	5 : 70	0.7 -- 2	1.93	N/A	136 N	1300	(a)	NO	B
100-41-4	ETHYLBENZENE	0.10	U	0.42	J	µg/L	00SW0615, 0.25	5 : 94	0.1 -- 0.282	0.12	N/A	134 N	700	(a)	NO	B
7782-41-4	FLUORIDE	97.00	J	98.00	J	µg/L	ECAMP03, 3	2 : 2	0.012 -- 0.012	98.00	N/A	220 N	4000	(a)	NO	B
NA	HARDNESS (AS CACO3)	12000.00		26000.00		µg/L	ECAMP05, 3	3 : 3	1 -- 1	26000.00	N/A	N/A	N/A		NO	G
7439-89-6	IRON	6.40	U	5000.00		µg/L	95SW1252, 57.45	25 : 97	6.4 -- 28.3	244.15	N/A	300 N1	300	(a)	NO	F
7439-89-6	IRON (TOTAL)	6.40	U	2200.00		µg/L	ECAMP02, 60	6 : 29	6.4 -- 15.6	421.04	N/A	300 N1	300	(a)	NO	F
439-92-1	LEAD	1.00	U	10.30		µg/L	ECAMP02, 20	1 : 70	1 -- 2.2	1.40	N/A	15 N1	15	(a)	NO	A
439-92-1	LEAD (TOTAL)	1.00	U	3.01		µg/L	ECAMP07, 31	1 : 12	1 -- 1.5	1.26	N/A	15 N1	15	(a)	NO	B
1330-20-7	M,P-XYLENE (SUM OF ISOMERS)	0.41	U	0.90	J	µg/L	95SW1221, 21.8	1 : 57	0.406 -- 0.406	0.22	N/A	143 N	10000	(a)	NO	A,B
7439-95-4	MAGNESIUM	1950.00	U	2320.00	J	µg/L	ECAMP07, 35	65 : 70	21.2 -- 1950	2154.94	N/A	N/A	N/A		NO	F
7439-95-4	MAGNESIUM (TOTAL)	1830.00		2130.00		µg/L	ECAMP05, 3	12 : 12	4.8 -- 39.4	1997.07	N/A	N/A	N/A		NO	F
7439-96-5	MANGANESE	0.46	U	5950.00		µg/L	ECAMP50, 43	41 : 97	0.46 -- 1.2	5950.00	N/A	50 N1	50	(a)	YES	C
7439-96-5	MANGANESE (TOTAL)	1.00	U	3650.00		µg/L	ECAMP02, 30	22 : 29	1 -- 1	3650.00	N/A	50 N1	50	(a)	YES	C
1634-04-4	METHYL-TERT-BUTYL-ETHER (MTBE)	0.09	U	4.58		µg/L	ECAMP04, 3	7 : 36	0.09 -- 0.32	0.60	N/A	2 N	20	(a)	YES	C
7440-02-0	NICKEL	0.70	U	15.20	J	µg/L	ECAMP51, 20	2 : 70	0.7 -- 1.4	0.89	N/A	73 N	100	(a)	NO	A,B
7727-37-9	NITROGEN	108.00	U	3090.00		µg/L	95SW1252, 57.45	193 : 196	43.5 -- 108	438.14	N/A	N/A	N/A		NO	G
7664-41-7	NITROGEN, AMMONIA (AS N)	0.90	U	1790.00		µg/L	ECAMP02, 62	182 : 212	0.9 -- 5	492.34	N/A	N/A	N/A		NO	G
NA	NITROGEN, KJELDAHL, TOTAL	300.00	U	1500.00		µg/L	ECAMP05, 3	1 : 3	0.3 -- 0.3	1500.00	N/A	N/A	N/A		NO	G
14797-55-8	NITROGEN, NITRATE (AS N)	0.90	U	211.00		µg/L	ECJNP04, 3	159 : 222	0.9 -- 0.9	150.17	N/A	10000 N1	10000	(a)	NO	B
NA	NITROGEN, NITRATE-NITRITE	63.00	J	76.00	J	µg/L	ECAMP05, 3	2 : 2	0.0053 -- 0.0053	76.00	N/A	10000 N1	10000	(a)	NO	B
14797-65-0	NITROGEN, NITRITE	0.90	U	60.00	J	µg/L	ECAMP07, 33	45 : 114	0.02 -- 0.9	2.97	N/A	1000 N1	1000	(a)	NO	B
7723-14-0	PHOSPHORUS, DISSOLVED (AS P)	1.50	U	764.00		µg/L	ECAMP02, 62	84 : 92	1.5 -- 15	185.02	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL (AS P)	1.50	U	629.00		µg/L	ECAMP02, 50	180 : 183	1.5 -- 15	42.39	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL HYDROLYZABLE (AS P)	0.60	U	1130.00		µg/L	ECAMP02, 62	68 : 91	0.6 -- 6	263.07	N/A	N/A	N/A		NO	G
7723-14-0	PHOSPHORUS, TOTAL PO4 (AS P)	0.60	U	921.00		µg/L	ECAMP02, 45	96 : 138	0.6 -- 6	26.57	N/A	N/A	N/A		NO	G
7440-09-7	POTASSIUM	1150.00	U	1470.00	J	µg/L	ECAMP52, 45	69 : 70	51.4 -- 1150	1247.94	N/A	N/A	N/A		NO	F
7440-09-7	POTASSIUM (TOTAL)	952.00	J	1290.00		µg/L	ECAMP07, 31	12 : 12	10.1 -- 20.6	1180.21	N/A	N/A	N/A		NO	F
7440-21-3	SILICON	111.00	U	6000.00	J	µg/L	ECAMP15, 3	64 : 66	7.4 -- 111	2103.55	N/A	N/A	N/A		NO	H
7440-23-5	SODIUM	9480.00	U	10850.00		µg/L	ECAMP02, 30	68 : 70	598 -- 9480	9691.44	N/A	20000 N1	20000	(a)	NO	B

Table 2-4
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Ashumet and Johns Pond Surface Water

Scenario Timeframe:	Current and Future
Medium:	Surface Water
Exposure Medium:	Surface Water
Exposure Point:	Ashumet Pond and Johns Pond

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Cocentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (2)	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Source	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
7440-23-5	SODIUM (TOTAL)	8020.00		9020.00		µg/L	ECAMP06, 18	12 : 12	28.4 -- 205	8762.53	N/A	20000 N1	20000	(a)	NO	B
14808-79-8	SULFATE (AS SO4)	1480.00	J	12100.00		µg/L	ECAMP51, 10	72 : 73	0.67 -- 1.34	9376.75	N/A	250000 N1	250000	(a)	NO	B
18496-25-8	SULFIDE	530.00	U	2380.00		µg/L	ECAMP07, 10	43 : 89	0.53 -- 0.53	769.46	N/A	N/A	N/A		NO	G,H
NA	SUSPENDED SOLIDS (RESIDUE, NON-FILT	4000.00	U	7000.00		µg/L	ECAMP03, 3	1 : 2	2.54 -- 4	7000.00	N/A	N/A	N/A		NO	G
7440-28-0	THALLIUM	0.70	U	4.62	J	µg/L	ECAMP01, 18	1 : 72	0.7 -- 4.5	2.40	N/A	0.24 N	1.7	(b)	NO	A
108-88-3	TOLUENE	0.09	U	1.55		µg/L	95SW1221, 21.8	25 : 94	0.09 -- 0.197	0.18	N/A	72.3 N	1000	(a)	NO	B
NA	TOTAL DISSOLVED SOLIDS	45000.00		66000.00		µg/L	ECAMP03, 3	3 : 3	4.95 -- 10	66000.00	N/A	500000 N1	500000	(a)	NO	B
79-01-6	TRICHLOROETHENE(TCE)	0.09	U	2.10		µg/L	00SW0615, 2	6 : 94	0.09 -- 0.09	0.21	N/A	1.64 C	2.7	(b)	YES	C
7440-66-6	ZINC	0.20	UJ	63.60		µg/L	ECAMP51, 20	23 : 70	0.2 -- 0.4	7.57	N/A	1090 N	5000	(a)	NO	B
7440-66-6	ZINC (TOTAL)	0.78	UJ	7.01		µg/L	ECAMP04, 30	6 : 12	0.4 -- 0.78	3.75	N/A	1090 N	5000	(a)	NO	B

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

J = Estimated Value.
N/A = Not Available.
U = Not Detected.
µg/L = micrograms per liter.
(1) Minimum/maximum detected concentration.
(2) Lower of the 95%UCL and the maximum detected concentration.
(3) Lowest water screening value available:
- C - EPA Region 9 PRG, November 2000. Residential Tap Water: Carcinogens.
- N - EPA Region 9 PRG, November 2000. Residential Tap Water: Non-carcinogens; based on a hazard quotient of 0.1.
- N1 - EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.
- N2 - EPA, April 1999. National Recommended Water Quality Criteria-Correction: Human Health - For Consumption of Water and Organism.

(a) EPA Drinking Water Standards and Health Advisories, Summer 2000; Massachusetts Drinking Water Standards and Guidelines, Spring 2000. Lower of the two.
(b) EPA, April 1999. National Recommended Water Quality Criteria-Correction: Human Health - For Consumption of Water and Organism.

[4] Rationale Codes
Reasons for elimination or selection
A - Frequency of detection is less than or equal to 5%.
B - Maximum detected concentration is less than water screening value.
C - Maximum detected concentration exceeds water screening value.
D - Screening values are not available.
E - Compound is retained because it is site-related.
F - Essential Nutrient.
G - General Chemistry Parameter.
H - Lack of toxicity criteria.

Table 2-5
Occurrence, Distribution, and Selection of Chemicals of Potential Concern, Ashumet and Johns Pond Sediment

Scenario Timeframe:	Current and Future
Medium:	Sediment
Exposure Medium:	Sediment
Exposure Point:	Ashumet Pond and Johns Pond

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifer	Maximum (1) Concentration	Maximum Qualifer	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background Value	Screening (3) Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (4) Contaminant Deletion or Selection
67-64-1	ACETONE	0.01	J	0.74	J	mg/kg	ECAMP06, 0	5 : 5	1.94 -- 36.5	0.74	N/A	160 N	N/A		NO	B
7429-90-5	ALUMINUM (TOTAL)	544.00	J	10200.00	J	mg/kg	ECAMP06, 0	2 : 2	1.83 -- 30.3	10200.00	N/A	7600 N	N/A		YES	C
7440-38-2	ARSENIC (TOTAL)	0.32	U	3.02	J	mg/kg	ECAMP06, 0	1 : 2	0.322 -- 2.65	3.02	N/A	0.39 C	N/A		YES	C
7440-39-3	BARIUM (TOTAL)	11.10	J	69.30	J	mg/kg	ECAMP06, 0	3 : 3	0.074 -- 0.318	69.30	N/A	540 N	N/A		NO	B
7440-41-7	BERYLLIUM (TOTAL)	0.05	UJ	0.73	J	mg/kg	ECAMP06, 0	2 : 3	0.049 -- 0.318	0.73	N/A	15 N	N/A		NO	B
117-81-7	BIS(2-ETHYLHEXYL) PHTHALATE	0.18	J	0.18	J	mg/kg	ECAMP06, 0	1 : 1	558 -- 558	0.18	N/A	35 C	N/A		NO	B
7440-42-8	BORON (TOTAL)	1.83	U	34.90	J	mg/kg	ECAMP06, 0	2 : 3	0.741 -- 1.83	34.90	N/A	550 N	N/A		NO	B
7440-43-9	CADMIUM (TOTAL)	0.07	U	1.41	J	mg/kg	ECAMP06, 0	1 : 2	0.074 -- 0.424	1.41	N/A	3.7 N	N/A		NO	B
7440-70-2	CALCIUM (TOTAL)	112.00	J	1190.00	J	mg/kg	ECAMP06, 0	3 : 3	4.62 -- 30.4	1190.00	N/A	N/A	N/A		NO	F
16887-00-6	CHLORIDE (AS CL)	5.84		58.30	J	mg/kg	ECJNP04, 0	8 : 8	0.477 -- 1.44	58.30	N/A	N/A	N/A		NO	G
67-66-3	CHLOROFORM	0.00	J	0.00	J	mg/kg	ECAMP15, 0	1 : 1	0.3 -- 0.3	0.0005	N/A	0.039 N	N/A		NO	B
18540-29-9	CHROMIUM (TOTAL)	1.43	J	18.20	J	mg/kg	ECAMP06, 0	3 : 3	0.198 -- 0.741	18.20	N/A	30 C	N/A		NO	B
7440-48-4	COBALT (TOTAL)	0.37	UJ	4.47	J	mg/kg	ECAMP06, 0	2 : 3	0.368 -- 0.741	4.47	N/A	470 N	N/A		NO	B
7440-50-8	COPPER (TOTAL)	1.52	U	14.80	J	mg/kg	ECAMP06, 0	2 : 3	0.53 -- 1.52	14.80	N/A	290 N	N/A		NO	B
206-44-0	FLUORANTHENE	0.20	J	0.20	J	mg/kg	ECAMP06, 0	1 : 1	613 -- 613	0.20	N/A	230 N	N/A		NO	B
7439-89-6	IRON (TOTAL)	1090.00		8950.00	J	mg/kg	ECAMP06, 0	3 : 3	3.09 -- 17	8950.00	N/A	2300 N	N/A		NO	F
439-92-1	LEAD (TOTAL)	5.95		136.00	J	mg/kg	ECAMP06, 0	3 : 3	0.42 -- 1.59	136.00	N/A	400 N	N/A		NO	B
7439-95-4	MAGNESIUM (TOTAL)	135.00	J	1610.00	J	mg/kg	ECAMP06, 0	3 : 3	1.19 -- 30.3	1610.00	N/A	N/A	N/A		NO	F
7439-96-5	MANGANESE (TOTAL)	173.00	J	706.00	J	mg/kg	ECAMP06, 0	3 : 3	0.45 -- 0.635	706.00	N/A	180 N	N/A		YES	C
7439-97-6	MERCURY	0.72	J	0.72	J	mg/kg	ECAMP06, 0	1 : 1	0.198 -- 0.198	0.72	N/A	2.3 N	N/A		NO	B
78-93-3	METHYL ETHYL KETONE (2-BUTANONE)	0.02	J	0.02	J	mg/kg	ECAMP15, 0	1 : 1	2 -- 2	0.02	N/A	730 N	N/A		NO	B
7440-02-0	NICKEL (TOTAL)	0.35	UJ	10.80	J	mg/kg	ECAMP06, 0	2 : 3	0.354 -- 0.847	10.80	N/A	160 N	N/A		NO	B
7664-41-7	NITROGEN, AMMONIA (AS N)	114.00		1580.00	J	mg/kg	ECAMP06, 0	8 : 8	15.3 -- 78.4	1580.00	N/A	N/A	N/A		NO	G
NA	NITROGEN, KJELDAHL, TOTAL	457.00		7820.00		mg/kg	ECJNP05, 0	8 : 8	21 -- 108	7820.00	N/A	N/A	N/A		NO	G
14797-55-8	NITROGEN, NITRATE (AS N)	0.55	J	2.78	J	mg/kg	ECJNP04, 0	3 : 3	0.086 -- 0.857	2.78	N/A	N/A	N/A		NO	G
NA	NITROGEN, NITRATE-NITRITE	0.67	J	3.04		mg/kg	ECAMP07, 0	5 : 5	0.0764 -- 0.189	3.04	N/A	N/A	N/A		NO	G
14797-65-0	NITROGEN, NITRITE	0.16	U	1.94	J	mg/kg	ECJNP04, 0	2 : 3	0.164 -- 0.874	1.94	N/A	N/A	N/A		NO	G
72-54-8	P,P'-DDD	0.00	U	0.03	J	mg/kg	ECAMP06, 0	1 : 2	0.695 -- 2.31	0.027	N/A	2.4 C	N/A		NO	B
72-55-9	P,P'-DDE	0.00	U	0.02	J	mg/kg	ECAMP06, 0	1 : 2	1.33 -- 4.44	0.023	N/A	1.7 C	N/A		NO	B
7723-14-0	PHOSPHORUS, TOTAL (AS P)	20.90	U	289.00		mg/kg	ECAMP04, 0	7 : 8	20.9 -- 5.64	289.00	N/A	N/A	N/A		NO	G
7440-09-7	POTASSIUM (TOTAL)	110.00	U	766.00	J	mg/kg	ECAMP06, 0	2 : 3	21.8 -- 110	766.00	N/A	N/A	N/A		NO	F
7782-49-2	SELENIUM (TOTAL)	0.63	J	2.23	J	mg/kg	ECAMP06, 0	3 : 3	0.544 -- 2.2	2.23	N/A	39 N	N/A		NO	B
7440-23-5	SODIUM (TOTAL)	130.00	J	130.00	J	mg/kg	ECAMP09, 0	1 : 1	68.2 -- 68.2	130.00	N/A	N/A	N/A		NO	F
14808-79-8	SULFATE (AS SO4)	13.60		187.00		mg/kg	ECJNP05, 0	8 : 8	3.2 -- 3.45	187.00	N/A	N/A	N/A		NO	G,H
NA	TOTAL ORGANIC CARBON	1320.00		60500.00	J	mg/kg	ECJNP05, 0	13 : 13	0.64 -- 1500	60500.00	N/A	N/A	N/A		NO	G
7440-62-2	VANADIUM (TOTAL)	2.07	U	32.20	J	mg/kg	ECAMP06, 0	2 : 3	0.847 -- 2.07	32.20	N/A	55 N	N/A		NO	B
7440-66-6	ZINC (TOTAL)	4.97	J	121.00	J	mg/kg	ECAMP06, 0	3 : 3	0.098 -- 0.424	121.00	N/A	2300 N	N/A		NO	B

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value.
mg/kg = milligrams per kilogram.
N/A = Not Available
U = Not Detected.
(1) Minimum/maximum detected concentration.
(2) Maximum detected concentration used as screening value.
(3) Lowest sediment screening value available:
C - EPA Region 9 PRG, November 2000. Residential Soil: Carcinogens.
N - EPA Region 9 PRG, November 2000. Residential Soil: Non-carcinogens; based on a hazard quotient of 0.1.

(4) Rationale Codes
Reasons for elimination or selection
A - Frequency of detection is less than or equal to 5%.
B - Maximum detected concentration is less than screening value.
C - Maximum detected concentration exceeds screening value.
D - Screening values are not available.
E - Compound is retained because it is site-related.
F - Essential Nutrient.
G - General Chemistry Parameter.

Table 2-6
Medium-Specific Exposure Point Concentrations Summary, TCE Plume

Scenario Timeframe:	Current (TCE Plume)
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located in TCE plume upgradient and downgradient of extraction well).

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifer	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statisitic	Medium EPC Rationale
1,2-DIBROMOETHANE (EDB)	µg/L	0.0029	N/A	0.04		µg/L	0.04	Max	Maximum Detected	0.0029	Mean	Arithmetic Mean
ALUMINUM (TOTAL)	µg/L	31.96	N/A	114.75	J	µg/L	114.75	Max	Maximum Detected	31.96	Mean	Arithmetic Mean
CHLOROFORM	µg/L	0.17	N/A	0.92	J	µg/L	0.92	Max	Maximum Detected	0.17	Mean	Arithmetic Mean
MANGANESE	µg/L	378.04	N/A	2650.00	J	µg/L	2650.00	Max	Maximum Detected	378.04	Mean	Arithmetic Mean
MANGANESE (TOTAL)	µg/L	131.33	N/A	324.00		µg/L	324.00	Max	Maximum Detected	131.33	Mean	Arithmetic Mean
METHYL-TERT-BUTYL-ETHER (MTBE)	µg/L	0.61	N/A	4.60		µg/L	4.60	Max	Maximum Detected	0.61	Mean	Arithmetic Mean
TETRACHLOROETHENE(PCE)	µg/L	0.66	N/A	6.29	J	µg/L	6.29	Max	Maximum Detected	0.66	Mean	Arithmetic Mean
TRICHLOROETHENE(TCE)	µg/L	133.09	N/A	2352.00		µg/L	2352.00	Max	Maximum Detected	133.09	Mean	Arithmetic Mean

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

J = Estimated Value.

N/A = Not Available

µg/L = Micrograms per liter.

Statistics: Maximum Detected Value (Max); Arithmetic Mean (Mean).

For nondetects, 1/2 detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

Table 2-7
Medium-Specific Exposure Point Concentrations Summary, Current CS-10 Leading Edge Groundwater

Scenario Timeframe:	Current
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located upgradient of Ashumet Pond, between Ashumet and Johns ponds, and downgradient of Johns Pond - and not within TCE plume).

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifer	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
1,2-DIBROMOETHANE (EDB)	µg/L	0.0031	N/A	0.04		µg/L	0.04	Max	Maximum Detected	0.0031	Mean	Arithmetic Mean
ALUMINUM	µg/L	36.45	N/A	474.00		µg/L	474.00	Max	Maximum Detected	36.45	Mean	Arithmetic Mean
ALUMINUM (TOTAL)	µg/L	110.40	N/A	1470.00		µg/L	1470.00	Max	Maximum Detected	110.40	Mean	Arithmetic Mean
ARSENIC	µg/L	1.18	N/A	3.10	J	µg/L	3.10	Max	Maximum Detected	1.18	Mean	Arithmetic Mean
ARSENIC (TOTAL)	µg/L	1.53	N/A	6.40		µg/L	6.40	Max	Maximum Detected	1.53	Mean	Arithmetic Mean
BORON (TOTAL)	µg/L	110.62	N/A	335.00		µg/L	335.00	Max	Maximum Detected	110.62	Mean	Arithmetic Mean
CIS-1,2-DICHLOROETHENE	µg/L	0.42	N/A	9.00		µg/L	9.00	Max	Maximum Detected	0.42	Mean	Arithmetic Mean
LEAD	µg/L	2.17	N/A	17.00		µg/L	17.00	Max	Maximum Detected	2.17	Mean	Arithmetic Mean
LEAD (TOTAL)	µg/L	1.56	N/A	30.60		µg/L	30.60	Max	Maximum Detected	1.56	Mean	Arithmetic Mean
MANGANESE	µg/L	350.71	N/A	2960.00		µg/L	2960.00	Max	Maximum Detected	350.71	Mean	Arithmetic Mean
MANGANESE (TOTAL)	µg/L	176.69	N/A	1570.00		µg/L	1570.00	Max	Maximum Detected	176.69	Mean	Arithmetic Mean
METHYL-TERT-BUTYL-ETHER (MTBE)	µg/L	0.22	N/A	2.40		µg/L	2.40	Max	Maximum Detected	0.22	Mean	Arithmetic Mean
TETRACHLOROETHENE(PCE)	µg/L	0.41	N/A	7.56		µg/L	7.56	Max	Maximum Detected	0.41	Mean	Arithmetic Mean
TRICHLOROETHENE(TCE)	µg/L	46.93	N/A	760.00		µg/L	760.00	Max	Maximum Detected	46.93	Mean	Arithmetic Mean

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

J = Estimated Value.

N/A = Not Available

µg/L = micrograms per liter.

Statistics: Maximum Detected Value (Max); Arithmetic Mean (Mean).

For nondetects, 1/2 detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

Table 2-8
Medium-Specific Exposure Point Concentrations Summary, Future CS-10 Leading Edge Groundwater

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water (Wells located upgradient of Ashumet Pond, underneath Ashumet Pond, between Ashumet and Johns ponds, and downgradient of Johns Pond - and not within TCE plume)

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifer	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
1,2-DIBROMOETHANE (EDB)	µg/L	0.0029	N/A	0.039		µg/L	0.04	Max	Maximum Detected	0.0029	Mean	Arithmetic Mean
ALUMINUM	µg/L	33.10	N/A	474.00		µg/L	474.00	Max	Maximum Detected	33.10	Mean	Arithmetic Mean
ALUMINUM (TOTAL)	µg/L	110.40	N/A	1470.00		µg/L	1470.00	Max	Maximum Detected	110.40	Mean	Arithmetic Mean
ARSENIC	µg/L	1.30	N/A	3.10	J	µg/L	3.10	Max	Maximum Detected	1.30	Mean	Arithmetic Mean
ARSENIC (TOTAL)	µg/L	1.53	N/A	6.40		µg/L	6.40	Max	Maximum Detected	1.53	Mean	Arithmetic Mean
BORON (TOTAL)	µg/L	109.18	N/A	335.00		µg/L	335.00	Max	Maximum Detected	109.18	Mean	Arithmetic Mean
CIS-1,2-DICHLOROETHENE	µg/L	0.38	N/A	9.00	J	µg/L	9.00	Max	Maximum Detected	0.38	Mean	Arithmetic Mean
LEAD	µg/L	2.01	N/A	17.00		µg/L	17.00	Max	Maximum Detected	2.01	Mean	Arithmetic Mean
LEAD (TOTAL)	µg/L	1.56	N/A	30.60		µg/L	30.60	Max	Maximum Detected	1.56	Mean	Arithmetic Mean
MANGANESE	µg/L	315.83	N/A	2960.00		µg/L	2960.00	Max	Maximum Detected	315.83	Mean	Arithmetic Mean
MANGANESE (TOTAL)	µg/L	176.69	N/A	1570.00		µg/L	1570.00	Max	Maximum Detected	176.69	Mean	Arithmetic Mean
METHYL-TERT-BUTYL-ETHER (MTBE)	µg/L	0.21	N/A	2.40		µg/L	2.40	Max	Maximum Detected	0.21	Mean	Arithmetic Mean
NICKEL	µg/L	3.52	N/A	86.15		µg/L	86.15	Max	Maximum Detected	3.52	Mean	Arithmetic Mean
TETRACHLOROETHENE(PCE)	µg/L	0.36	N/A	7.56	J	µg/L	7.56	Max	Maximum Detected	0.36	Mean	Arithmetic Mean
TRICHLOROETHENE(TCE)	µg/L	38.83	N/A	856.70		µg/L	856.70	Max	Maximum Detected	38.83	Mean	Arithmetic Mean

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

J = Estimated Value.

N/A = Not Available

µg/L = micrograms per liter.

Statistics: Maximum Detected Value (Max); Arithmetic Mean (Mean).

For nondetects, 1/2 detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

Table 2-9
Medium-Specific Exposure Point Concentrations Summary, Ashumet and Johns Pond Surface Water

Scenario Timeframe:	Current and Future
Medium:	Surface Water
Exposure Medium:	Surface Water
Exposure Point:	Ashumet Pond and Johns Pond

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifer	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
ANTIMONY (TOTAL)	µg/L	1.05	1.23	1.80	J	µg/L	1.23	95% UCL-T	W- Test (1)	1.05	Mean	Arithmetic Mean
BIS(2-ETHYLHEXYL) PHTHALATE	µg/L	6.31	26.82	25.90		µg/L	25.90	Max	W - Test (2)	6.31	Mean	Arithmetic Mean
MANGANESE	µg/L	849.98	44646.54	5950.00		µg/L	5950.00	Max	W - Test (2)	849.98	Mean	Arithmetic Mean
MANGANESE (TOTAL)	µg/L	823.25	111725.66	3650.00		µg/L	3650.00	Max	W - Test (2)	823.25	Mean	Arithmetic Mean
METHYL-TERT-BUTYL-ETHER (MTBE)	µg/L	0.44	0.60	4.58		µg/L	0.60	95% UCL -T	W - Test (1)	0.44	Mean	Arithmetic Mean
TRICHLOROETHENE(TCE)	µg/L	0.20	0.21	2.10		µg/L	0.21	95% UCL -T	W - Test (1)	0.20	Mean	Arithmetic Mean

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

J = Estimated Value.

N/A = Not Available

µg/L = micrograms per liter.

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).
Mean of Normal Data (Mean-N).

For nondetects, 1/2 detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

(1) Shapiro-Wilks W Test indicates data are log-normally distributed.

(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

Table 2-10
Medium-Specific Exposure Point Concentrations Summary
Ashumet and Johns Pond Sediment

Scenario Timeframe:	Current and Future
Medium:	Sediment
Exposure Medium:	Sediment
Exposure Point:	Ashumet Pond and Johns Pond

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifer	EPC Units	Reasonable Maximum Exposure			Central Tendency (a)		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
ALUMINUM (TOTAL)	mg/kg	5372.00	N/A	10200.00	J	mg/kg	10200.00	Max	Maximum Detected	10200.00	Max	Maximum Detected
ARSENIC (TOTAL)	mg/kg	1.59	N/A	3.02	J	mg/kg	3.02	Max	Maximum Detected	3.02	Max	Maximum Detected
MANGANESE (TOTAL)	mg/kg	522.67	N/A	706.00	J	mg/kg	706.00	Max	Maximum Detected	706.00	Max	Maximum Detected

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

J = Estimated Value.

mg/kg = milligrams per kilogram.

N/A = Not Available

Statistics: Maximum Detected Value (Max); Arithmetic Mean (Mean).

For nondetects, 1/2 detection limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

(a) - Due to the limited number of sediment samples (3 or fewer samples), the maximum detected concentrations were used.

Table 2-11
Values Used for Daily Intake Calculations
Adult-Groundwater

Scenario Timeframe: Current and Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: All wells
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Ratioinale/Reference	CT Value	CT Rationale/Reference	Intake Equation/Model Name
Ingestion	EF	Exposure Frequency	days/year	350	(b)	350	(b)	
	ED	Exposure Duration	year	24	(b)	7	(b)	Average Daily Dose (ADD)(mg/kg-day)=
	IR	Water Ingestion Rate	liter/event	2	(b)	1.41	(a)	CW x IR x EF x ED x 1/BW x AAF x 1/AT x CF1
	BW	Body Weight	kg	71.8	(c,d)	71.8	(c,d)	
	AAF	Absorption Adjustment Factor (water-oral)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	CW	Concentration in Water	µg/L	See Tables 3.1-3	--	See Tables 3.1-3	--	
	CF1	Conversion Factor	mg/µg	0.001	--	0.001	--	
	AT-C	Averaging Time (Cancer)	days	25,550	(b)	25550	(b)	
	AT-NC	Averaging Time (Non-Cancer)	days	8760	(b)	2555	(b)	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

(a) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.
Recommended average tapwater intake rate for adult.

(b) - EPA, 1994. U.S. EPA Region I Risk Update. August 1994.
Exposure duration for the CTE resident is 2 years for child and 7 years for adult.
Exposure duration for the RME resident is 6 years for child and 24 years for adult.

(c) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.

(d) - Average body weight for adult males and females. Table 7-2 (US EPA, 1997).

Table 2-12
Values Used for Daily Intake Calculations
Adult-Surface Water

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Ashumet Pond, Johns Pond
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/Model Name
Ingestion								
	EF	Exposure Frequency	days/year	34	(e)	17	(e)	Average Daily Dose (ADD)(mg/kg-day)=
	ED	Exposure Duration	year	24	(b)	7	(b)	CW x IR x EF x ED x 1/BW x AAF x 1/AT x CF1
	IR	Water Ingestion Rate	liter/event	0.13	(f)	0.13	(f)	
	BW	Body Weight	kg	71.8	(c,d)	71.8	(c,d)	
	AAF	Absorption Adjustment Factor (water-oral)	unitless	See Tables A-2	--	See Tables A-2	--	
	CW	Concentration in Water	µg/L	See Table 3.4	--	See Table 3.4	--	
	CF1	Conversion Factor	mg/µg	0.001	--	0.001	--	
	AT-C	Averaging Time (Cancer)	days	25,550	(b)	25550	(b)	
	AT-NC	Averaging Time (Non-Cancer)	days	8760	(b)	2555	(b)	
Dermal								
	ET	Exposure Time	hr/event	2.6	(f)	2.6	(f)	Average Daily Dose (ADD)(mg/kg-day)=
	EF	Exposure Frequency	days/year	34	(e)	17	(e)	Dermally Absorbed Dose (DAD)
	ED	Exposure Duration	year	24	(b)	7	(b)	
	EV	Event Frequency	events/day	1	(a)	1	(a)	DAD (mg/kg-day) =
	SA	Skin Contacting Medium	cm^2	18150	(b,c)	18150	(b,c)	DAevent x EV x EF x ED x SA x 1/BW x 1/AT
	BW	Body Weight	kg	71.8	(c,d)	71.8	(c,d)	For Inorganics:
	CW	Concentration in Water	µg/L	See Table 3.4	--	See Table 3.4	--	Absorbed Dose per Event (DAevent)
	CF1	Conversion Factor	mg/µg	0.001	--	0.001	--	(mg/cm^2-event) = CW x PC x ET x CF1 x CF2
	AT-C	Averaging Time (Cancer)	days	25550	(b)	25550	(b)	if ET < t*
	AT-NC	Averaging Time (Non-Cancer)	days	8760	(b)	2555	(b)	DAevent (mg/cm^2-event)=
	PC	Permeability Constant	cm/hr	See Appendix A-1	--	See Appendix A-1	--	$2 \times PC \times CW \times CF1 \times CF2 \times (6 \times T \times ET \times 1/pi)^{1/2}$
	CF2	Conversion Factor	L/cm^3	0.001	--	0.001	--	if ET > t*
	pi	Pi	--	3.14	--	3.14	--	DAevent (mg/cm^2-event)=
	T	Lag Time	hr	See Appendix A-1	--	See Appendix A-1	--	PC x CW x CF1 x CF2 x
	t*	Time to Steady State	hr	See Appendix A-1	--	See Appendix A-1	--	[(ET/1+B) + 2 x T {(1+3B)/(1+B)}]
	B	Dimensionless Constant	--	See Appendix A-1	--	See Appendix A-1	--	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).
(a) - Best professional judgement.
(b) - EPA, 1994. U.S. EPA Region I Risk Update. August 1994.
Exposure duration for the CTE resident is 2 years for child and 7 years for adult.
Exposure duration for the RME resident is 6 years for child and 24 years for adult.
(c) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.
(d) - Average body weight for adult males and females. Table 7-2 (US EPA, 1997).
(e) - Best professional judgement:
RME - 4 days per week during the warmest months (17 weeks).
CTE - 2 days per week during the warmest months (17 weeks).
(f) - EPA, 1989. RAGS, Vol I.

Table 2-13
Values Used for Daily Intake Calculations
Adult-Sediment

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Ashumet Pond, Johns Pond
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion								
	EF	Exposure Frequency	days/year	34	(a)	17	(a)	Average Daily Dose (ADD)(mg/kg-day)=
	ED	Exposure Duration	year	24	(b)	7	(b)	CS x IR x EF x ED x 1/BW x AAF x 1/AT x CF3
	IR	Sediment Ingestion Rate	mg/day	100.00	(g)	50	(g)	
	BW	Body Weight	kg	71.8	(c,d)	71.8	(c,d)	
	AAF	Absorption Adjustment Factor (soil-oral)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	CS	Concentration in Sediment	mg/kg	See Table 3.5	--	See Table 3.5	--	
	CF3	Conversion Factor	kg/mg	0.000001	--	0.000001	--	
	AT-C	Averaging Time (Cancer)	days	25,550	(f)	25550	(f)	
	AT-NC	Averaging Time (Non-Cancer)	days	8760	(f)	2555	(f)	
Dermal								
	EF	Exposure Frequency	days/year	34	(j)	17	(j)	Average Daily Dose (ADD)(mg/kg-day)=
	ED	Exposure Duration	year	24	(b)	7	(b)	CS x SA x AAF x AF x EF x ED x CF x 1/BW x 1/AT x CF3
	SA	Surface Area	cm^2/day	5809	(c,e)	5809	(c,e)	
	AAF	Absorption Adjustment Factor (soil-dermal)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	AF	Adherence Factor	mg/cm^2	0.5	(h)	0.5	(h)	
	BW	Body Weight	kg	71.8	(c,d)	71.8	(c,d)	
	CS	Concentration in Sediment	mg/kg	See Table 3.5	--	See Table 3.5	--	
	CF3	Conversion Factor	kg/mg	0.000001	--	0.000001	--	
	AT-C	Averaging Time (Cancer)	days	25550	(f)	25550	(f)	
	AT-NC	Averaging Time (Non-Cancer)	days	8760	(f)	2555	(f)	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).
(a) - Best professional judgement:
RME - 4 days per week during the warmest months (17 weeks).
CTE - 2 days per week during the warmest months (17 weeks).
(b) - EPA, 1994. U.S. EPA Region I Risk Update. August 1994.
Exposure duration for the CTE resident is 2 years for child and 7 years for adult.
Exposure duration for the RME resident is 6 years for child and 24 years for adult.
(c) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.
(d) - Average body weight for adult males and females. Table 7-2 (US EPA, 1997).
(e) - Assumed exposure to hands, forearms, lower legs, and feet.
(f) - EPA, 1989. RAGS, Vol I.
(g) - Sediment ingestion rate assumed to equal soil ingestion rate.
(h) - EPA, 1992. Dermal Exposure Assessment. Principles and Applications. Interim Report. EPA/600/8-89/043.

Table 2-14
Values Used for Daily Intake Calculations
Child-Groundwater

Scenario Timeframe: Current and Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: All Wells
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CT Value	CT Rationale/Reference	Intake Equation/Model Name
Ingestion	EF	Exposure Frequency	days/year	350	(b)	350	(b)	
	ED	Exposure Duration	year	6	(b)	2	(b)	Average Daily Dose (ADD)(mg/kg-day)=
	IR	Water Ingestion Rate	liter/event	1	(b)	0.74	(a)	CW x IR x EF x ED x 1/BW x AAF x 1/AT x CF1
	BW	Body Weight	kg	15	(b)	15	(b)	
	AAF	Absorption Adjustment Factor (water-oral)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	CW	Concentration in Water	µg/L	See Tables 3.1-3	--	See Tables 3.1-3	--	
	CF1	Conversion Factor	mg/µg	0.001	--	0.001	--	
	AT-C	Averaging Time (Cancer)	days	25,550	(b)	25550	(b)	
	AT-NC	Averaging Time (Non-Cancer)	days	2190	(b)	730	(b)	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

(a) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.

Average drinking water intake rate for child between age 1 to 6 year old.

(b) - EPA, 1994. U.S. EPA Region I Risk Update. August 1994.

Exposure duration for the CTE resident is 2 years for child and 7 years for adult.

Exposure duration for the RME resident is 6 years for child and 24 years for adult.

Table 2-15
Values Used for Daily Intake Calculations
Child-Surface Water

Scenario Timeframe: Current and Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Ashumet Pond and Johns Pond
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CT Value	CT Rationale/Reference	Intake Equation/Model Name
Ingestion								
	EF	Exposure Frequency	days/year	68	(a)	34	(a)	Average Daily Dose (ADD)(mg/kg-day)=
	ED	Exposure Duration	year	6	(b)	2	(b)	CW x IR x EF x ED x 1/BW x AAF x 1/AT x CF1
	IR	Water Ingestion Rate	liter/event	0.13	(d)	0.13	(d)	
	BW	Body Weight	kg	15	(b)	15	(b)	
	AAF	Absorption Adjustment Factor (water-oral)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	CW	Concentration in Water	µg/L	See Table 3.4	--	See Table 3.4	--	
	CF1	Conversion Factor	mg/ug	0.001	--	0.001	--	
	AT-C	Averaging Time (Cancer)	days	25,550	(b)	25550	(b)	
	AT-NC	Averaging Time (Non-Cancer)	days	2190	(b)	730	(b)	
Dermal								
	ET	Exposure Time	hr/event	2.6	(d)	2.6	(d)	Average Daily Dose (ADD)(mg/kg-day)=
	EF	Exposure Frequency	days/year	68	(a)	34	(a)	Dermally Absorbed Dose (DAD)
	ED	Exposure Duration	year	6	(b)	2	(b)	
	EV	Event Frequency	events/day	1	(d)	1	(d)	DAD (mg/kg-day) =
	SA	Skin Contacting Medium	cm^2	7195	(c)	7195	(c)	DAevent x EV x EF x ED x SA x 1/BW x 1/AT
	BW	Body Weight	kg	15	(b)	15	(b)	For Inorganics:
	CW	Concentration in Water	µg/L	See Table 3.4	--	See Table 3.4	--	Absorbed Dose per Event (DAevent)
	CF1	Conversion Factor	mg/ug	0.001	--	0.001	--	(mg/cm^2-event) = CW x PC x ET x CF1 x CF2
	AT-C	Averaging Time (Cancer)	days	25550	(b)	25550	(b)	if ET < t*
	AT-NC	Averaging Time (Non-Cancer)	days	2190	(b)	730	(b)	DAevent (mg/cm^2-event)=
	PC	Permeability Constant	cm/hr	See Appendix A-1	--	See Appendix A-1	--	$2 \times PC \times CW \times CF1 \times CF2 \times (6 \times T \times ET \times 1/pi)^{1/2}$
	CF2	Conversion Factor	L/cm^3	0.001	--	0.001	--	if ET > t*
	pi	Pi	--	3.14	--	3.14	--	DAevent (mg/cm^2-event)=
	T	Lag Time	hr	See Appendix A-1	--	See Appendix A-1	--	PC x CW x CF1 x CF2 x
	t*	Time to Steady State	hr	See Appendix A-1	--	See Appendix A-1	--	[(ET/1+B) + 2 x T [(1+3B)/(1+B)]]
	B	Dimensionless Constant	--	See Appendix A-1	--	See Appendix A-1	--	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

(a) - Best professional judgement:
RME - 4 days per week during the warmest months (17 weeks).
CTE - 2 days per week during the warmest months (17 weeks).

(b) - EPA, 1994. U.S. EPA Region I Risk Update. August 1994.
Exposure duration for the CTE resident is 2 years for child and 7 years for adult.
Exposure duration for the RME resident is 6 years for child and 24 years for adult.

(c) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.

(d) - EPA, 1989. RAGS, Vol I.

Table 2-16
Values Used for Daily Intake Calculations
Child-Sediment

Scenario Timeframe: Current and Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Ashumet Pond and Johns Pond
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CT Value	CT Rationale/Reference	Intake Equation/Model Name
Ingestion								
	EF	Exposure Frequency	days/year	68	(a)	34	(a)	Average Daily Dose (ADD)(mg/kg-day)=
	ED	Exposure Duration	year	6	(b)	2	(b)	CS x IR x EF x ED x 1/BW x AAF x 1/AT x CF3
	IR	Sediment Ingestion Rate	mg/day	200.00	(d)	100	(d)	
	BW	Body Weight	kg	15	(b)	15	(b)	
	AAF	Absorption Adjustment Factor (soil-oral)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	CS	Concentration in Sediment	mg/kg	See Table 3.5	--	See Table 3.5	--	
	CF3	Conversion Factor	kg/mg	0.000001	--	0.000001	--	
	AT-C	Averaging Time (Cancer)	days	25,550	(b)	25550	(b)	
	AT-NC	Averaging Time (Non-Cancer)	days	2190	(b)	730	(b)	
Dermal								
	EF	Exposure Frequency	days/year	68	(a)	34	(a)	Average Daily Dose (ADD)(mg/kg-day)=
	ED	Exposure Duration	year	6	(b)	2	(b)	CS x SA x AAF x AF x EF x ED x CF x 1/BW x 1/AT x CF3
	SA	Surface Area	cm^2/day	2085	(c,e)	2085	(c,e)	
	AAF	Absorption Adjustment Factor (soil-dermal)	unitless	See Appendix A-2	--	See Appendix A-2	--	
	AF	Adherence Factor	mg/cm^2	0.5	(f)	0.5	(f)	
	BW	Body Weight	kg	15	(b)	15	(b)	
	CS	Concentration in Sediment	mg/kg	See Table 3.5	--	See Table 3.5	--	
	CF3	Conversion Factor	kg/mg	0.000001	--	0.000001	--	
	AT-C	Averaging Time (Cancer)	days	25550	(b)	25550	(b)	
	AT-NC	Averaging Time (Non-Cancer)	days	2190	(b)	730	(b)	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).
(a) - Best professional judgement:
RME - 4 days per week during the warmest months (17 weeks).
CTE - 2 days per week during the warmest months (17 weeks).
(b) - EPA, 1994. U.S. EPA Region I Risk Update. August 1994.
Exposure duration for the CTE resident is 2 years for child and 7 years for adult.
Exposure duration for the RME resident is 6 years for child and 24 years for adult.
(c) - EPA, 1997. Exposure Factors Handbook Volume 1, EPA 600/P-95/002Fa. August 1997.
(d) - Sediment ingestion rate assumed to equal soil ingestion rate.
(e) - Assumed exposure to hands, forearms, lower legs, and feet.
(f) - EPA, 1992. Dermal Exposure Assessment. Principles and Applications. Interim Report. EPA/600/8-89/043.

Table 2-17
Non-Cancer Chronic Toxicity Data - Oral/Dermal

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal-Water Absorption Adjustment Factor (1)	Adjusted Water-Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (MM/DD/YY)
1,2-DIBROMOETHANE	Chronic	2.0E-05	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Reproductive	N/A	MADEP	12/15/94
	Subchronic	2.0E-04	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Reproductive	N/A	MADEP	12/15/94
ALUMINUM	Chronic	1.0E+00	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Neurotoxicity	N/A	NCEA	06/15/97
	Subchronic	1.0E+00	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Neurotoxicity	N/A	(Chronic RfD)	06/15/97
ANTIMONY	Chronic	4.0E-04	mg/kg-day	6.7	6.0E-05	mg/kg-day	Blood	1000	IRIS	12/15/00
	Subchronic	4.0E-04	mg/kg-day	6.7	6.0E-05	mg/kg-day	Blood	1000	HEAST	07/15/97
ARSENIC	Chronic	3.0E-04	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Skin	3	IRIS	12/15/00
	Subchronic	3.0E-04	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Skin	3	HEAST	07/15/97
BIS(2-ETHYLHEXYL)PHTHALATE	Chronic	2.0E-02	mg/kg-day	1	2.0E-02	mg/kg-day	Liver	1000	IRIS	12/15/00
	Subchronic	2.0E-02	mg/kg-day	1	2.0E-02	mg/kg-day	Liver	1000	(Chronic RfD)	12/15/00
BORON	Chronic	9.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Reproductive	100	IRIS	12/15/00
	Subchronic	9.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Reproductive	100	(Chronic RfD)	12/15/00
CHLOROFORM	Chronic	1.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Liver	1000	IRIS	12/15/00
	Subchronic	1.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Liver	1000	HEAST	07/15/97
CIS-1,2-DICHLOROETHENE	Chronic	1.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Blood	3000	HEAST	07/15/97
	Subchronic	1.0E-01	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Blood	300	HEAST	07/15/97
LEAD	Chronic	N/A	mg/kg-day	NCOPC	NCOPC	mg/kg-day	N/A	N/A	(a)	N/A
	Subchronic	N/A	mg/kg-day	NCOPC	NCOPC	mg/kg-day	N/A	N/A	N/A	N/A
MANGANESE (b)	Chronic	2.4E-02	mg/kg-day	17	1.4E-03	mg/kg-day	CNS	1	(d)	08/15/99
	Subchronic	1.4E-01	mg/kg-day	17	8.3E-03	mg/kg-day	CNS	1	HEAST	07/15/97
METHYL-TERT-BUTYL-ETHER (MTBE)	Chronic	1.0E-01	mg/kg-day	1	1.0E-01	mg/kg-day	N/A	N/A	MADEP	12/15/94
	Subchronic	1.0E-01	mg/kg-day	1	1.0E-01	mg/kg-day	N/A	N/A	(Chronic RfD)	12/15/94
NICKEL	Chronic	2.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Organ Body Weight	300	IRIS	12/15/00
	Subchronic	2.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Organ Body Weight	300	HEAST	07/15/97
TETRACHLOROETHENE	Chronic	1.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Kidney	1000	IRIS	12/15/00
	Subchronic	1.0E-01	mg/kg-day	NCOPC	NCOPC	mg/kg-day	Kidney	100	HEAST	07/15/97
TRICHLOROETHENE	Chronic	6.0E-03	mg/kg-day	1	6.0E-03	mg/kg-day	Liver	N/A	NCEA	06/15/97
	Subchronic	6.0E-03	mg/kg-day	1	6.0E-03	mg/kg-day	Liver	N/A	(Chronic RfD)	06/15/97
MANGANESE (c)	Chronic	7.0E-02	mg/kg-day	NCOPC	NCOPC	mg/kg-day	CNS	1	(d)	08/15/99
	Subchronic	N/A	mg/kg-day	NCOPC	NCOPC	mg/kg-day	NA	NA	N/A	N/A

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).
CNS = Central Nervous System.
HEAST = Health Effects Assessment Summary Tables, published annually by the USEPA (1997).
IRIS = Integrated Risk Information System, an on-line computer database of toxicological information (USEPA, 2000).
MassDEP = Massachusetts Department of Environmental Protection (1994).
N/A = Not Available.
NCEA = National Center for Environmental Assessment.
NCOPC = Not Compound of Potential Concern for surface water..
(1) Used to evaluate dermal exposure to surface water. Refer to Appendix D-1 for documentation on Absorption Adjustment Factors (AAFs).
(2) Adjusted Water-Dermal RfD = Oral RfD/Oral to Dermal-Water Absorption Adjustment Factors (AAFs),

Table 2-18
Cancer Toxicity Data - Oral/Dermal

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal-Water Absorption Adjustment Factor (1)	Adjusted Water-Dermal Cancer Slope Factor (2)	Units	Weight of Evidence/Cancer Guideline Description	Source	Date (MM/DD/YY)
1,2-DIBROMOETHANE	85	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	12/15/00
ALUMINUM	N/A	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	N/A	N/A	N/A
ANTIMONY	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	12/15/00
ARSENIC	1.5	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	A	IRIS	12/15/00
BIS(2-ETHYLHEXYL)PHTHALATE	0.014	1	0.014	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	12/15/00
BORON	N/A	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	12/15/00
CHLOROFORM	0.0061	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	12/15/00
CIS-1,2-DICHLOROETHENE	N/A	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	D	IRIS	12/15/00
LEAD	N/A	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	12/15/00
MANGANESE	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	D	IRIS	12/15/00
METHYL-TERT-BUTYL-ETHER (MTBE)	N/A	N/A	N/A	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	12/15/00
NICKEL	N/A	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	N/A	IRIS	12/15/00
TETRACHLOROETHENE	0.052	NCOPC	NCOPC	$(mg/kg\text{-}day)^{-1}$	C/B2	NCEA	06/15/97
TRICHLOROETHENE	0.011	1	0.011	$(mg/kg\text{-}day)^{-1}$	B2	NCEA	06/15/97

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

CSF = Cancer Slope Factor.

HEAST = Health Effects Assessment Summary Tables.

IRIS = Integrated Risk Information System.

N/A = Not Available.

NCEA = National Center For Environmental Assessment.

NCOPC = Not Compound of Potential Concern for surface water.

(1) Used to evaluate dermal exposure to surface water.

Refer to Appendix D-1 for documentation on Absorption Adjustment Factors (AAFs).

(2) Adjusted Water-Dermal CSF = Oral CSF x Oral to Dermal-Water Absorption Adjustment Factors (AAFs),

where Dermal-Soil AAF = Absorption efficiency by dermal-water route / Absorption efficiency in dose-response study used to derive oral CSF.

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data ar

B2 - Probable human carcinogen - indicates sufficient evidence in anim

inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

Weight of Evidence:

Known/Likely

Cannot be Determined

Not Likely

Table 2-19
Risk Assessment Summary Reasonable Maximum Exposure, TCE Plume, Current, Adult

Scenario Timeframe:	Current (TCE Plume)
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water (Wells located in TCE Plume upgradient and downgradient of extraction well)	1,2-DIBROMOETHANE (EDB)	2.80E-05	-	-	2.80E-05	MANGANESE	CNS	2.95E+00	-	-	2.95E+00
			TETRACHLOROETHENE(PCE)	3.00E-06	-	-	3.00E-06	TRICHLOROETHENE(TCE)	Liver	1.05E+01	-	-	1.05E+01
			TRICHLOROETHENE(TCE)	2.37E-04	-	-	2.37E-04						
			(Total)				**2.68E-04**	(Total)					**1.34E+01**
Surface Water	Surface Water	Ashumet Pond and Johns Pond	BIS(2-ETHYLHEXYL) PHTHALATE	2.10E-08	-	1.97E-06	1.99E-06		--	--	--	--	--
			(Total)				**1.99E-06**	(Total)					--
Sediment	Sediment	Ashumet Pond and Johns Pond		--	--	--	--		--	--	--	--	--
			(Total)				--	(Total)					--

Total Risk Across[Medium]	--
Total Risk Across All Media and All Exposure Routes	**2.70E-04**
Total Hazard Index Across All Media and All Exposure Routes	**1.34E+01**

Total [Reproductive] HI =	--
Total [Neurotoxicity] HI =	--
Total [Blood] HI =	--
Total [Skin] HI =	--
Total [Liver] HI =	**1.05E+01**
Total [CNS] HI =	**2.95E+00**
Total [Body Weight] HI =	--
Total [Kidney] HI =	--

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

Table 2-20
Risk Assessment Maximum Exposure,
TCE Plume, Current, Child

Scenario Timeframe:	Current (TCE Plume)
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water (Wells located in TCE Plume upgradient and downgradient of extraction well)	1,2-DIBROMOETHANE (EDB)	1.68E-05	-	-	1.68E-05	MANGANESE	CNS	7.06E+00	-	-	7.06E+00
			TETRACHLOROETHENE(PCE)	1.79E-06	-	-	1.79E-06	TRICHLOROETHENE(TCE)	Liver	2.51E+01	-	-	2.51E+01
			TRICHLOROETHENE(TCE)	1.42E-04	-	-	1.42E-04						
			(Total)				**1.60E-04**	(Total)					**3.21E+01**
Surface Water	Surface Water	Ashumet Pond and Johns Pond	BIS(2-ETHYLHEXYL) PHTHALATE	5.02E-08	-	1.87E-06	1.92E-06		--	--	--	--	--
			(Total)				**1.92E-06**	(Total)					**--**
Sediment	Sediment	Ashumet Pond and Johns Pond	ARSENIC	9.06E-07	-	1.52E-07	1.06E-06		--	--	--	--	--
			(Total)				**1.06E-06**	(Total)					**--**

Total Risk Across[Medium]	--
Total Risk Across All Media and All Exposure Routes	**1.63E-04**
Total Hazard Index Across All Media and All Exposure Routes	**3.21E+01**
Total [Reproductive] HI =	--
Total [Neurotoxicity] HI =	--
Total [Blood] HI =	--
Total [Skin] HI =	--
Total [Liver] HI =	**2.51E+01**
Total [CNS] HI =	**7.06E+00**
Total [Body Weight] HI =	--
Total [Kidney] HI =	--

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

Table 2-21
Risk Assessment Summary, Reasonable Maximum Exposure,
CS-10 Leading Edge Groundwater, Current, Adult

Scenario Timeframe:	Current
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water (Wells located upgradient of Ashumet Pond, between Ashumet and Johns Ponds, and downgradient of Johns Pond - and not within TCE Plume)	1,2-DIBROMOETHANE (EDB)	3.04E-05	-	-	3.04E-05	MANGANESE	CNS	3.29E+00	-	-	3.29E+00
			ARSENIC	8.79E-05	-	-	8.79E-05	TRICHLOROETHENE(TCE)	Liver	3.38E+00	-	-	3.38E+00
			TETRACHLOROETHENE(PCE)	3.60E-06	-	-	3.60E-06						
			TRICHLOROETHENE(TCE)	7.66E-05	-	-	7.66E-05						
			(Total)				**1.98E-04**	(Total)					**6.68E+00**
Surface Water	Surface Water	Ashumet Pond and Johns Pond	BIS(2-ETHYLHEXYL) PHTHALATE	2.10E-08	-	1.97E-06	1.99E-06		--	--	--	--	--
			(Total)				**1.99E-06**	(Total)					--
Sediment	Sediment	Ashumet Pond and Johns Pond							--	--	--	--	--
			(Total)				**0.00E+00**	(Total)					--

Total Risk Across[Medium]	--
Total Risk Across All Media and All Exposure Routes	**2.00E-04**
Total Hazard Index Across All Media and All Exposure Routes	**6.68E+00**

Total [Reproductive] HI =	--
Total [Neurotoxicity] HI =	--
Total [Blood] HI =	--
Total [Skin] HI =	--
Total [Liver] HI =	**3.38E+00**
Total [CNS] HI =	**3.29E+00**
Total [Body Weight] HI =	--
Total [Kidney] HI =	--

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

Table 2-22
Risk Assessment Summary, Reasonable Maximum Exposure,
CS-10 Leading Edge Groundwater, Current, Child

Scenario Timeframe:	Current
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water (Wells located upgradient of Ashumet Pond, between Ashumet and Johns Ponds, and downgradient of Johns Pond - and not within TCE Plume)	1,2-DIBROMOETHANE (EDB)	1.82E-05	-	-	1.82E-05	ARSENIC	Skin	1.36E+00	-	-	1.36E+00
			ARSENIC	5.26E-05	-	-	5.26E-05	MANGANESE	CNS	7.88E+00	-	-	7.88E+00
			TETRACHLOROETHENE(PCE)	2.15E-06	-	-	2.15E-06	TRICHLOROETHENE(TCE)	Liver	8.10E+00	-	-	8.10E+00
			TRICHLOROETHENE(TCE)	4.58E-05	-	-	4.58E-05						
			(Total)				**1.19E-04**	(Total)					**1.73E+01**
Surface Water	Surface Water	Ashumet Pond and Johns Pond	BIS(2-ETHYLHEXYL) PHTHALATE	5.02E-08	-	1.87E-06	1.92E-06		--	--	--	--	--
			(Total)				**1.92E-06**	(Total)					--
Sediment	Sediment	Ashumet Pond and Johns Pond	ARSENIC	9.06E-07	-	1.52E-07	1.06E-06		--	--	--	--	--
			(Total)				**1.06E-06**	(Total)					--

Total Risk Across[Medium]	--
Total Risk Across All Media and All Exposure Routes	**1.22E-04**
Total Hazard Index Across All Media and All Exposure Routes	**1.73E+01**
Total [Reproductive] HI =	--
Total [Neurotoxicity] HI =	--
Total [Blood] HI =	--
Total [Skin] HI =	**1.36E+00**
Total [Liver] HI =	**8.10E+00**
Total [CNS] HI =	**7.88E+00**
Total [Body Weight] HI =	--
Total [Kidney] HI =	--

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

Table 2-23
Risk Assessment Summary
Reasonable Maximum Exposure,
CS-10 Leading Edge Groundwater, Future, Adult

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water (Wells located upgradient of Ashumet Pond, underneath Ashumet Pond, between Ashumet and Johns Ponds, and downgradient of Johns Pond - and not within TCE Plume)	1,2-DIBROMOETHANE (EDB)	3.04E-05	-	-	3.04E-05	MANGANESE	CNS	3.29E+00	-	-	3.29E+00
			ARSENIC	8.79E-05	-	-	8.79E-05	TRICHLOROETHENE(TCE)	Liver	3.81E+00	-	-	3.81E+00
			TETRACHLOROETHENE(PCE)	3.60E-06	-	-	3.60E-06						
			TRICHLOROETHENE(TCE)	8.63E-05	-	-	8.63E-05						
			(Total)				**2.08E-04**	(Total)					**7.11E+00**
Surface Water	Surface Water	Ashumet Pond and Johns Pond	BIS(2-ETHYLHEXYL) PHTHALATE	2.10E-08	-	1.97E-06	1.99E-06		--	--	--	--	--
			(Total)				**1.99E-06**	(Total)					--
Sediment	Sediment	Ashumet Pond and Johns Pond		--	--	--	--		--	--	--	--	--
			(Total)				--	(Total)					--

Total Risk Across[Medium]	--
Total Risk Across All Media and All Exposure Routes	**2.10E-04**
Total Hazard Index Across All Media and All Exposure Routes	**7.11E+00**
Total [Reproductive] HI =	--
Total [Neurotoxicity] HI =	--
Total [Blood] HI =	--
Total [Skin] HI =	--
Total [Liver] HI =	**3.81E+00**
Total [CNS] HI =	**3.29E+00**
Total [Body Weight] HI =	--
Total [Kidney] HI =	--

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

Table 2-24
Risk Assessment Summary, Reasonable Maximum Exposure, CS-10 Leading Edge Groundwater, Future, Child

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water (Wells located upgradient of Ashumet Pond, underneath Ashumet Pond, between Ashumet and Johns Ponds, and downgradient of Johns Pond - and not within TCE Plume)	1,2-DIBROMOETHANE (EDB)	1.82E-05	-	-	1.82E-05	ARSENIC	Skin	1.36E+00	-	-	1.36E+00
			ARSENIC	5.26E-05	-	-	5.26E-05	MANGANESE	CNS	7.88E+00	-	-	7.88E+00
			TETRACHLOROETHENE(PCE)	2.15E-06	-	-	2.15E-06	TRICHLOROETHENE(TCE)	Liver	9.13E+00	-	-	9.13E+00
			TRICHLOROETHENE(TCE)	5.16E-05	-	-	5.16E-05						
			(Total)				**1.25E-04**	(Total)					**1.84E+01**
Surface Water	Surface Water	Ashumet Pond and Johns Pond	BIS(2-ETHYLHEXYL) PHTHALATE	5.02E-08	-	1.87E-06	1.92E-06		--	--	--	--	--
			(Total)				**1.92E-06**	(Total)					--
Sediment	Sediment	Ashumet Pond and Johns Pond	ARSENIC	9.06E-07	-	1.52E-07	1.06E-06		--	--	--	--	--
			(Total)				**1.06E-06**	(Total)					--

Total Risk Across[Medium]	--
Total Risk Across All Media and All Exposure Routes	**1.28E-04**
Total Hazard Index Across All Media and All Exposure Routes	**1.84E+01**

Total [Reproductive] HI =	--
Total [Neurotoxicity] HI =	--
Total [Blood] HI =	--
Total [Skin] HI =	**1.36E+00**
Total [Liver] HI =	**9.13E+00**
Total [CNS] HI =	**7.88E+00**
Total [Body Weight] HI =	--
Total [Kidney] HI =	--

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

Table 2-25
Comparison of Current Toxicity Values to 1996 and 2001 Risk Assessments

Analyte	Sfo (mg/kg-day)$^{-1}$	1996 Sfo (mg/kg-day)$^{-1}$	2001 Sfo (mg/kg-day)$^{-1}$	IUR (µg/m^3)$^{-1}$	1996 Sfi (mg/kg-day)	Sfi to IUR Conversion	RfDo (mg/kg-day)	1996 RfDo (mg/kg-day)	2001 RfDo (mg/kg-day)	RfCi (mg/m^3)	1996 RfDi (mg/kg-day)
Aluminum							1.00E+00	1.00E+00	1.00E+00	5.00E-03	
Arsenic	1.50E+00		1.50E+00	4.00E-03	5.00E+01	1.00E-02	3.00E-04	3.00E-04	3.00E-04	3.00E-05	
Barium							2.00E-01	7.00E-02		5.00E-04	5.00E-04
Benzene	5.50E-02	2.90E-02		8.00E-06	2.90E-02	8.00E-06	4.00E-03			3.00E-02	
Beryllium and compounds		4.30E+00		2.00E-03	8.40E+00	2.00E-03	2.00E-03	5.00E-03		2.00E-05	
Boron							2.00E-01		9.00E-02	2.00E-02	
Bromodichloromethane	6.20E-02						2.00E-02				
Cadmium (Diet)				2.00E-03			1.00E-03	5.00E-04			
Chlordane	3.50E-01			1.00E-04			5.00E-04			7.00E-04	
Chloroform	3.10E-02		6.10E-03	2.00E-05			1.00E-02		1.00E-02	9.80E-02	
Chromium VI (particulates)				8.00E-02	4.20E+01	1.00E-02	3.00E-03	5.00E-03		1.00E-04	
Cobalt				9.00E-03			3.00E-04			6.00E-06	
Copper							4.00E-02				
1,2-Dibromoethane (Ethylene Dibromide)	2.00E+00	8.50E+01	8.50E+01	6.00E-04	7.60E-01	2.00E-04	9.00E-03		2.00E-05	9.00E-03	
Dichloroethylene, 1,1-		6.00E-01			1.20E+00	3.00E-04	5.00E-02	9.00E-03		2.00E-01	
Dichloropropene, 1,3-	1.00E-01			4.00E-06			3.00E-02			2.00E-02	
Iron							7.00E-01	5.00E-01			
Manganese							2.40E-02	5.00E-03	2.40E-02	5.00E-05	5.00E-05
Methyl-tert-butyl-ether (MTBE)	1.80E-03			3.00E-07					1.00E-01	3.00E+00	
Naphthalene				3.00E-05			2.00E-02	4.00E-02		3.00E-03	
Styrene							2.00E-01	2.00E-01		1.00E+00	2.86E-01
Tetrachloroethane, 1,1,2,2-	2.00E-01	2.00E-01		6.00E-05	2.00E-01	6.00E-05	4.00E-03				
Tetrachloroethylene	5.40E-01		5.20E-02	6.00E-06			1.00E-02	1.00E-02	1.00E-02	2.70E-01	
Trichloroethylene	1.30E-02	1.10E-02	1.10E-02	2.00E-06	6.00E-03	2.00E-06		7.00E-03	6.00E-03		
Trimethylbenzene, 1,2,4-										7.00E-03	
Trimethylbenzene, 1,3,5-							5.00E-02			6.00E-03	
Vanadium and Compounds							5.00E-03	7.00E-03			
Xylene, Mixture							2.00E-01	2.00E+00		1.00E-01	
Xylene, o-							2.00E+00	2.00E+00		7.00E-01	

Note: This table was produced in support of the Final Chemical Spill-10 Remedial Investigation Report (AFCEE 2001b).

IUR = Inhalation Unit Risk
kg = kilogram
m^3 = cubic meter
mg = milligram
RfCi = Reference Concentration - Inhalation
RfDi = Reference Dose - Inhalation
RfDo = Reference Dose - Oral
SFi = Slope Factor - Inhalation
SFo = Slope Factor - Oral
µg = micrograms

Table 2-26
Evaluation of CS-10 Groundwater Alternatives 1 through 6 from 2007 CS-10 FS Addendum

Alternative	Overall Protection	ARARs	Long-Term Effectiveness	Short-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Implementability	Cost[1]
1 No Action	Not Protective	No ARARs	Good	Poor	Poor	Good	$0 M
2 Long-Term Monitoring (LTM) with Land Use Controls (LUCs)	Protective	Yes	Good	Poor	Poor	Good	$27 M
3 Continue to operate and optimize the existing CS-10 ETR and ETI systems (In-Plume, Sandwich Road, NL), LTM, and LUCs (Preferred).	**Protective**	**Yes**	**Good**	**Good**	**Fair**	**Good**	**$59 M**
4 Continue to operate and optimize the existing CS-10 ETR and ETI systems (In-plume, Sandwich Road, NL), additional extraction in the NCL, LTM, and LUCs.	Protective	Yes	Good	Good	Good	Good	$60 M
5 Continue to operate and optimize the existing CS-10 ETR and ETI systems (In-Plume, Sandwich Road, NL), additional extraction in the NCL, SL, LTM, and LUCs.	Protective	Yes	Good	Poor	Good	Good	$62 M
6 Continue to operate and optimize the existing CS-10 ETR and ETI systems (In-Plume, Sandwich Road, NL), additional extraction in the NCL, and installation of a permeable reactive barrier in the SL, LTM, and LUCs.	Protective	Yes	Good	Poor	Good	Poor	$69 M

[1] Present value costs do not include those for interim remedial action taken prior to the signing of the final ROD. The present value costs were calculated for the entire lifetime of the individual alternatives using a discount rate of 3.0 percent. All costs for the main body and leading edge are included in the cost. The costs of the final remedy were revised in 2009. Refer to Section 2.10.2.7.

Bold text indicates the selected alternative.

ARAR = applicable or relevant and appropriate requirement
ETI = extraction, treatment, and infiltration
ETR = extraction, treatment, and reinjection
LTM = long-term monitoring
LUC = land use control
M = million
NL = Northern Lobe
NCL = North Central Lobe
SL = Southern Lobe
SCL = South Central Lobe

Table 2-27
Evaluation of CS-10 Groundwater Alternatives 7 through 10 from 2008 Supplement to the CS-10 FS Addendum

Alternative	Overall Protection	ARARs	Long-Term Effectiveness	Short-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume Through Treatment	Implementability	Cost[1]
7 No Action for the main body of the plume.	Not Protective	No ARARs	Good	Poor	Poor	Good	$0 M
8 Long-Term Monitoring with Land Use Controls (LUCs) for the main body of the plume.	Protective	Yes	Good	Poor	Poor	Good	$9 M
9 Continue to operate and optimize the CS-10 In-Plume and Sandwich Road ETR/ETI systems, and LTM and LUCs for the main body of the plume.	Protective	Yes	Good	Good	Fair	Good	$29 M
10 Continue to operate and optimize the CS-10 In-Plume and Sandwich Road ETR/ETI systems, expansion, treatment in the Southern Trench area, LTM and LUCs for the main body of the plume (Preferred).	**Protective**	**Yes**	**Good**	**Good**	**Good**	**Good**	**$30 M**

[1] Present value costs do not include those for interim remedial action taken prior to the signing of the final ROD. The present value costs were calculated for the entire length of the individual alternatives using a discount rate of 2.8 percent. The costs solely address the main body. The costs of the final remedy were revised in 2009. Refer to Section 2.10.2.7.

Bold text indicates the selected alternative.
ARAR = applicable or relevant and appropriate requirement
ETI = extraction, treatment, and infiltration
ETR = extraction, treatment, and reinjection
LTM = long-term monitoring
LUC = land use control
M = million

Table 2-28
Restoration Time Frames and Mass Removal Estimates
Of Alternatives 1 through 6 from 2007 CS-10 FS Addendum

	Alternative 1	Alternative 2	**Alternative 3**	Alternative 4	Alternative 5	Alternative 6
Estimated Year When Cleanup is Achieved						
CS-10 Main Body	2113	2113	**2108**	2108	2108	2108
CS-10 Northern Lobe	2044	2044	**2046**	2046	2046	2046
CS-10 North Central Lobe	2025	2025	**2025**	2024	2024	2024
CS-10 Southern Lobe	2027	2027	**2027**	2027	2018	2022
CS-10 related contamination east of Johns Pond[1]	2017	2017	**2017**	2017	2017	2017
Cumulative TCE and PCE Mass Removal (lb) During Anticipated Main Body and/or Leading Edge System Operation						
	NA	NA	**1,391**	1,392	1,401	1,392[2]

Bold text indicates the selected alternative.

[1] Contaminant concentrations east of Johns Pond have decreased since the FS was conducted. Based on 2006 monitoring results CS-10 related contamination east of Johns Pond is not mappable at concentrations above the appropriate cleanup level.

[2] Approximately 2 lb is degraded by the permeable reactive barrier.

Table 2-29
Restoration Time Frames and Mass Removal Estimates of Alternatives 7 through 10 from 2008 Supplement to CS-10 FS Addendum

	Alternative 7	Alternative 8	Alternative 9	**Alternative 10**
Estimated year When Cleanup is Achieved				
In Plume Area	2088	2088	2089	**2094**
Sandwich Road Area	2069	2069	2048	**2038**
Southern Trench Area	2085	2085	2023	**2020**
TCE Mass Removal (lb) For Main Body ETI/ETR Systems				
	NA	NA	1,125	**1,191**

Bold text indicates the selected alternative.
lb = pounds

Table 2-30
Chemical-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Groundwater	FEDERAL - SDWA – MCLs (40 CFR 141.61-141.63)	MCLs have been promulgated for organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but are also considered relevant and appropriate for CERCLA groundwater response actions where the groundwater aquifer is used or classified for use as drinking water.	These standards will be used as cleanup standards to be met through cleanup of the CS-10 plume, unless a more stringent state standard has been promulgated, in which case the more stringent standard will be met. LTM will determine when these cleanup standards are met.	Relevant and Appropriate
Groundwater	FEDERAL - SDWA – Non-Zero MCLGs (40 CFR 141.50-141.51)	Non-zero MCLGs are nonenforceable health goals for public water systems set at levels that would result in no known or expected adverse health effects with an adequate margin of safety. Non-zero MCLGs are also considered relevant and appropriate for CERCLA groundwater response actions where the groundwater aquifer is used or classified for use as drinking water.	These standards will be used as cleanup standards to be met through cleanup of the CS-10 plume, unless a more stringent state standard has been promulgated, in which case the more stringent standard will be met. LTM will determine when these cleanup standards are met.	Relevant and Appropriate
Groundwater	STATE – MA Drinking Water Standards (310 CMR 22.05-22.09)	These standards establish MCLs for public drinking water systems, but are also considered relevant and appropriate for CERCLA groundwater contamination response actions. When state MCLs are more stringent than federal levels, state levels must be used.	These standards will be used as cleanup standards to be met through cleanup of the CS-10 plume if these standards are more stringent than federal drinking water standards. LTM will determine when these cleanup standards are met.	Relevant and Appropriate
Groundwater	STATE – MA Groundwater Quality Standards (314 CMR 6.06)	These standards limit the concentration of certain materials allowed in classified Massachusetts waters. The groundwater beneath MMR has been classified as a Class I water or fresh groundwater found in the saturated zone of unconsolidated deposits and is designated as a source of potable water. The standards for Class I groundwater are the same as the state's MCLs.	These standards will be used as cleanup standards to be met through cleanup of the CS-10 plume. LTM will determine when these cleanup standards are met.	Applicable

Table 2-30
Chemical-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Groundwater	FEDERAL – Risk Reference Doses (RfDs)	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants. RfDs are considered the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	These guidances will be used to determine human health risks from contaminated groundwater and to define final cleanup standards for the CS-10 plume. The residual risk assessment, if deemed necessary, will use the most up-to-date RfDs for all contaminants.	TBC
Groundwater	FEDERAL – Cancer Slope Factors (CSFs)	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants. CSFs represent EPA's most-up-to-date information on cancer risk.	These guidances will be used to determine human health risks from contaminated groundwater and to define final cleanup standards for the CS-10 plume.	TBC
Groundwater	FEDERAL – Guidelines for Carcinogen Risk Assessment - EPA/630/P-03/001F (March 2005)	These guidelines are used to perform human health risk assessments.	These guidances will be used to determine human health risks from contaminated groundwater and to define final cleanup standards for the CS-10 plume.	TBC
Groundwater	FEDERAL – Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens - EPA/630/R-03/003F (March 2005)	These guidelines are used to perform human health risk assessments.	These guidances will be used to determine human health risks from contaminated groundwater and to define final cleanup standards for the CS-10 plume.	TBC

ARAR applicable or relevant and appropriate requirement
CERCLA Comprehensive Environmental Response, Compensation and Liability Act
CFR *Code of Federal Regulations*
CMR *Code of Massachusetts Regulations*
CS-10 Chemical Spill-10
CSF cancer slope factor
EPA U.S. Environmental Protection Agency
MA Massachusetts
MCL maximum contaminant level
MCLG maximum contaminant level goal MMR Massachusetts Military Reservation
RfD reference dose
SDWA Safe Drinking Water Act
TBC to be considered (guidance)

Table 2-31
Location-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Endangered and threatened species and their habitats	STATE – MA Endangered Species Act (321 CMR 10.00 et seq.)	Actions that jeopardize state-listed endangered or threatened species; or species of special concern or their habitats must be avoided, or appropriate mitigation measures must be taken.	The operation and maintenance of the remedial treatment systems, as well as the construction of any new monitoring wells, extraction well, reinjection well, or pipelines, will be designed to minimize effects to endangered or threatened species. Several state-listed species have been identified on the MMR. The Camp Edwards Natural Resource Office (http://www.eandrc.org/rarespecies.htm) continues to search for, identify, and map locations of rare species on the MMR and provides this information to the Massachusetts Division of Fisheries and Wildlife.	Applicable
Historic, archeological, and Native American artifacts and resources	FEDERAL – NHPA (16 USCA 470 et seq.; 36 CFR 800); AHPA (16 USCA 469a-c); ARPA (16 USC 470aa-ll; 43 CFR 7); NAGPRA (25 USCA 3001-3013; 43 CFR 10)	These statutes and regulations provide for the protection of historical, archaeological, and Native American burial sites, artifacts, and objects that might be lost as a result of a federal construction project. If a discovery is made, all activity in the area must stop and reasonable effort must be made to secure and protect the objects discovered.	After consultation with the Wampanoag Indian Tribes and the SHPO, the parties may determine that a cultural resources survey is needed to discover and identify objects and artifacts, particularly Native American artifacts of the Wampanoag Indian Tribes, if the monitoring wells, extraction well, reinjection well, or pipelines needs to be sited in areas that may have such resources. All such resources discovered during a survey or inadvertently discovered during on-site remedial activities will be secured and protected as required by law and in accordance with the consulting parties' memorandum of agreement.	Applicable
Historic, archeological, and Native American artifacts and resources	STATE – MA Historic Preservation Act (MGL Ch. 9 Sections 26-27C; MGL Ch. 7, Section 38A; MGL Ch. 38 Sections 6B-6C; and 950 CMR 70-71)	The MHC is the state historic preservation office and is authorized by Massachusetts law to identify, evaluate, and protect the Commonwealth's important historic and archaeological resources. The MHC administers state and federal preservation programs, including planning, review, and compliance.	After consultation with the Wampanoag Indian Tribes and the SHPO, the parties may determine that a cultural resources survey is needed to discover and identify objects and artifacts, particularly Native American artifacts of the Wampanoag Indian Tribes, if the monitoring wells, extraction well, reinjection well, or pipelines need to be sited in areas that may have such resources. All such resources discovered during a survey or inadvertently discovered during on-site remedial activities will be secured and protected as required by law and in accordance with the consulting parties' memorandum of agreement.	Applicable

Table 2-31
Location-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Wetlands	FEDERAL – Protection of Wetlands (EO 11990, 40 CFR 6, Appendix A)	Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and beneficial values of wetlands. Appendix A requires that no remedial alternatives adversely affect a wetland if another practicable alternative is available. If no alternative is available, effects from implementing the alternative must be mitigated.	These requirements are ARARs only if new treatment systems or SPEIM wells are sited in areas that would impact wetlands. The operation and maintenance of the treatment and well systems and construction of any new SPEIM wells, if needed, would be designed to minimize adverse effects to such wetlands and comply with these requirements.	Applicable
Wetlands	FEDERAL – Clean Water Act (CWA) Section 404 (40 CFR 230; 33 CFR Parts 320-323)	No activity that adversely affects a wetland shall be permitted if a practicable alternative with fewer effects is available. If no practicable alternative exists, impacts must be mitigated.	These requirements are ARARs only if new treatment systems or SPEIM wells are sited in areas that would adversely impact wetlands. Such potential impacts will be mitigated to comply with CWA 404 requirements.	Applicable
Wetlands	STATE – MassDEP Wetlands Protection Act (MGL Ch. 131, Section 40) and regulations (310 CMR 10.00)	This regulation outlines performance standards that must be met to work within 100 feet of a coastal or inland wetland and within 200 feet of a river. It governs all work involving the filling, dredging, or alteration of wetlands, banks, land under water bodies, waterways, land subject to flooding, and riverfront areas.	These requirements are ARARs only if new treatment systems or SPEIM wells are sited in areas that would adversely impact wetlands. The construction, operation, and maintenance of such systems and wells would be designed to meet the performance standards in 310 CMR 10.21 through 10.60 to minimize adverse effects to nearby wetlands.	Applicable
Wetlands	FEDERAL – Fish and Wildlife Coordination Act (40 CFR 6.302; 16 USC 661 et seq.)	This act and regulations require federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife, and to consult with the U.S. Fish and Wildlife Service and the state to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	These requirements are ARARs only if new treatment systems or SPEIM wells are sited in areas that would adversely impact water bodies including wetlands. Remedial actions would be designed to minimize and/or compensate for adverse effects to fish and wildlife in any water bodies including wetland areas. Relevant federal and state agencies will be contacted, if indicated, to help analyze the effects of the systems or wells on fish and wildlife in water bodies including wetlands in and around the site.	Applicable

Table 2-31
Location-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Floodplains	FEDERAL – Protection of Floodplains (EO 11988, 40 CFR 6, Appendix A)	Requires federal agencies to minimize potential harm to or within floodplains and avoid the long- and short-term adverse impacts with modifications to floodplains. Appendix A requires that no remedial alternatives adversely affect a floodplain if another practicable alternative is available. If no alternative is available, effects from implementing the alternative must be mitigated.	These requirements are ARARs only if new treatment systems or SPEIM wells are sited in floodplains. If the placement of any such system or well is needed, these requirements will be complied with if the location of the new well(s) is within or affecting a floodplain.	Applicable
Floodplains	STATE – MassDEP Wetland Protection Act (MGL Ch. 131, Section 40, and 310 CMR 10.00)	Governs work proposed within land subject to flooding (100-year floodplain) and coastal storm flow. Compensatory flood storage is required for any loss of floodplain area.	These requirements are ARARs only if new treatment systems or SPEIM wells are sited in floodplains. If the placement of any such system or well is needed, these requirements will be complied with if the location of the new well(s) is within or affecting a floodplain.	Applicable

AHPA Archaeological and Historic Preservation Act
ARAR applicable or relevant and appropriate requirement
ARPA Archaeological Resources Protection Act
CFR Code of Federal Regulations
Ch. chapter
CMR Code of Massachusetts Regulations
CS-10 Chemical Spill-10
MA Massachusetts
MGL Massachusetts General Law
MHC Massachusetts Historic Commission
MMR Massachusetts Military Reservation
NAGPRA Native American Graves Protection and Repatriation Act
NHPA National Historic Preservation Act
SHPO State Historic Preservation Officer
USC United States Code
USCA United States *Code, Annotated*

Table 2-32
Action-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Groundwater	FEDERAL – Underground Injection Control (UIC) Program (40 CFR 144-148)	These regulations outline minimum program and performance standards for underground injection wells and prohibit any injection into the aquifer that may cause a violation of any primary drinking water regulation under 40 CFR 142. The state program has been authorized by EPA and takes effect through the state requirements listed below.	SPEIM will be conducted to determine when groundwater contaminant levels are at or below the most stringent federal and state primary drinking water standards. Groundwater and monitoring well sample water will be treated prior to release to ensure that releases will not cause any violation of drinking water standards in the receiving aquifer.	Applicable
Groundwater	STATE – MA Underground Water Source Protection (310 CMR 27.00 et seq.)	These regulations prohibit the injection of fluid containing any pollutant into underground sources of drinking water where such pollutant will or is likely to cause a violation of any state drinking water regulations under 310 CMR 22.00 or adversely affect the health of persons.	SPEIM will be conducted to determine when groundwater contaminant levels are at or below the most stringent federal and state primary drinking water standards. Groundwater and monitoring well sample water will be treated prior to release to ensure that releases will not cause any violation of drinking water standards in the receiving aquifer.	Applicable
Groundwater	STATE – MassDEP Drinking Water Program, Private Well Guidelines (2008), available at http://www.mass.gov/dep/water/laws/prwellgd.doc	These are guidelines concerning well location, design, construction, development, water quality testing, operation, maintenance, and decommissioning.	These guidelines will be used in locating, designing, constructing, developing, testing, operating, maintaining, and decommissioning monitoring wells, extraction wells, and reinjection wells, and testing and decommissioning private water supply wells.	TBC
Surface water	STATE – Surface Water Quality Standards (314 CMR 4.00)	These standards limit the concentration of certain materials allowed in classified Massachusetts surface waters. The surface water surrounding the MMR has been classified as Class SA and SB coastal waters and Class B inland water.	Levels of contaminants in untreated groundwater currently discharging to surface water bodies are below applicable surface water quality standards. SPEIM will verify that levels of contaminants in untreated groundwater discharging to surface water bodies continue to fall below applicable surface water quality standards in order to monitor the groundwater remedy.	Applicable
Air	STATE – MA Air Pollution Control Regulations (310 CMR 7.06, 7.08 – 7.10, 7.14, and 7.18 – 7.24)	Establishes the standards and requirements for air pollution control in the Commonwealth. Potentially relevant sections include those pertaining to: visible emissions (7.06); dust, odor, construction, and demolition (7.09); and noise (7.10). The regulations also contain air pollutant emission standards for, among other things, hazardous waste incinerators, organic materials, and VOCs.	Dust, noise, and visible emissions will be managed to meet the state requirements during remedial and SPEIM activities, including the construction of new extraction wells, reinjection wells, pipelines, and monitoring wells. Air emissions are not expected to be at a level high enough to trigger the standards for hazardous waste incinerators, organic materials, or VOCs.	Applicable

Table 2-32
Action-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Stormwater runoff	FEDERAL – CWA NPDES Stormwater Discharge Requirements (40 CFR 122.26)	Establishes requirements for stormwater discharges associated with construction activities that result in a land disturbance area of equal to or greater than one acre of land. The requirements include good construction management techniques; phasing of construction projects; minimal clearing; and sediment, erosion, structural, and vegetative controls to be implemented to mitigate stormwater run-on and runoff.	If monitoring wells, extraction wells, reinjection wells, or pipelines need to be sited in areas that would trigger stormwater runoff releases to any nearby surface water body, including wetlands, and the area of land disturbance is greater than one acre of land, the runoff will be controlled in accordance with these requirements.	Applicable
Stormwater runoff	STATE – Stormwater Discharge Requirements (314 CMR 3.04 and 314 CMR 3.19)	Requires that stormwater discharges associated with construction activities be managed in accordance with the general permit conditions of 314 CMR 3.19 so as not to cause a violation of Massachusetts surface water quality standards in the receiving surface water body (including wetlands).	If monitoring wells, extraction wells, reinjection wells, or pipelines need to be sited in areas that would trigger stormwater runoff releases to any nearby surface water body, including wetlands, and the area of land disturbance is greater than one acre of land, the runoff will be controlled in accordance with these requirements.	Applicable
Stormwater runoff	STATE – Stormwater Management Program Policy (November 18, 1996)	Provides policies and guidance on complying with the state's stormwater discharge requirements.	If monitoring wells, extraction wells, reinjection wells, or pipelines need to be sited in areas that would trigger stormwater runoff releases to any nearby surface water body, including wetlands, the runoff will be controlled in accordance with this policy.	TBC
Soil	STATE – MA Erosion and Sediment Control Guidelines for Urban and Suburban Areas (May 2003)	Provides guidance and best management practices regarding erosion and sediment control.	Construction, operation, and maintenance of treatment systems, wells, and pipelines will be performed in accordance with this guidance.	TBC
Hazardous waste	FEDERAL – Subtitle C Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264 et seq.)	These requirements establish minimum national standards that define the acceptable management of hazardous waste.	Because Massachusetts has been authorized to run the RCRA base program, hazardous materials will be managed according to the state requirements listed below.	Applicable

Table 2-32
Action-Specific ARARs for CS-10 Groundwater Selected Remedy
(Alternative 10 for the main body and Alternative 3 for leading edge)

Media	Requirements	Requirement Synopsis	Action to be Taken to Attain Requirements	Status
Hazardous waste	STATE – MA HWMR Requirements for Generators of Hazardous Waste (310 CMR 30.300-30.305)	A generator of solid waste must determine whether that waste is hazardous using various methods, including the TCLP method, or application of knowledge of hazardous characteristics of the waste. If waste is determined to be hazardous, it must be managed in accordance with applicable Massachusetts generator requirements, which require management in accordance with 310 CMR 30.000 et seq.	Hazardous materials generated during the remedial action will be managed in accordance with these regulations and disposed of off-site in a RCRA-permitted treatment, storage, and disposal facility.	Applicable
Hazardous waste	STATE – RCRA Identification and Listing of Hazardous Waste (310 CMR 30.120-125)	These requirements identify the concentrations of contaminants at or above which the waste would be considered characteristically hazardous waste.	RCRA status of groundwater, monitoring well samples, soils, and other materials generated during remedial activities, including well installations, will be determined based on generator knowledge or prescribed test methods. Materials will be analyzed as necessary. If results exceed the standards in 310 CMR 30.120-125, the material will be managed in accordance with hazardous waste regulations.	Applicable

ARAR applicable or relevant and appropriate requirement
CFR *Code of Federal Regulations*
CMR *Code of Massachusetts Regulations*
CS-10 Chemical Spill-10
CWA Clean Water Act
HWMR Hazardous Waste Management Regulation
MA Massachusetts
MassDEP Massachusetts Department of Environmental Protection
NPDES National Pollutant Discharge Elimination System
RCRA Resource Conservation and Recovery Act
SPEIM system performance and ecological impact monitoring
TBC to be considered (guidance)
TCLP Toxicity Characteristic Leaching Procedure
VOC volatile organic compound

Table 2-33
Present Value Calculation for CS-10 Groundwater Operable Unit Selected Remedy
(Alternative 10 for the main body and Alternative 3 for the leading edge)

Year	Treatment System Construction & Startup Costs	Baseline Monitoring Costs	O&M	Monitoring	Periodic Costs	Total Cost (0% Discount)	Discount Factor (for 2.8%)	Total Present Value Cost at 2.8%	Calendar Year
0	$1,418,463	$20,608	$1,738,210	$1,077,955		$4,255,236	1.0000	$4,255,236	2009
1			$1,467,714	$1,370,956		$2,838,670	0.9728	$2,761,352	2010
2			$1,461,965	$799,423		$2,261,388	0.9463	$2,139,877	2011
3			$1,440,822	$1,088,807		$2,529,629	0.9205	$2,328,506	2012
4			$1,440,822	$575,150	$3,136	$2,015,972	0.8954	$1,805,145	2013
5			$1,370,713	$1,088,807		$2,459,520	0.8710	$2,142,322	2014
6			$1,351,856	$575,150		$1,927,006	0.8473	$1,632,768	2015
7			$1,157,041	$994,757		$2,151,798	0.8242	$1,773,576	2016
8			$1,150,327	$531,743		$1,682,070	0.8018	$1,348,649	2017
9			$926,419	$994,757	$3,136	$1,924,312	0.7799	$1,500,850	2018
10			$884,606	$531,743		$1,416,349	0.7587	$1,074,581	2019
11			$694,964	$907,942		$1,602,906	0.7380	$1,182,997	2020
12			$678,347	$491,953		$1,170,300	0.7179	$840,194	2021
13			$504,723	$907,942		$1,412,665	0.6984	$986,572	2022
14			$504,723	$491,953	$3,136	$999,811	0.6794	$679,226	2023
15			$261,349	$907,942		$1,169,291	0.6609	$772,727	2024
16			$261,349	$491,953		$753,302	0.6429	$484,261	2025
17			$261,349	$831,979		$1,093,328	0.6253	$683,703	2026
18			$261,349	$455,780		$717,129	0.6083	$436,236	2027
19			$261,349	$831,979	$3,136	$1,096,464	0.5917	$648,821	2028
20			$231,874	$455,780		$687,654	0.5756	$395,829	2029
21			$231,874	$763,250		$995,124	0.5599	$557,214	2030
22			$172,660	$423,224		$595,884	0.5447	$324,574	2031
23			$118,027	$763,250		$881,277	0.5299	$466,950	2032
24			$118,027	$423,224	$3,136	$544,386	0.5154	$280,590	2033
25			$118,027	$763,250		$881,277	0.5014	$441,860	2034
26			$118,027	$423,224		$541,250	0.4877	$263,984	2035
27			$388,929	$701,756		$1,090,684	0.4744	$517,470	2036
28			$388,929	$394,286		$783,214	0.4615	$361,471	2037
29			$388,929	$701,756	$3,136	$1,093,820	0.4490	$491,073	2038
30			$377,429	$307,470		$684,899	0.4367	$299,111	2039
31			$329,570	$578,768		$908,338	0.4248	$385,888	2040
32			$329,570	$307,470		$637,041	0.4133	$263,262	2041
33			$329,570	$542,595		$872,165	0.4020	$350,611	2042
34			$318,070	$289,384	$3,136	$610,590	0.3911	$238,772	2043
35			$318,070	$506,422		$824,492	0.3804	$313,637	2044
36			$277,513	$289,384		$566,896	0.3700	$209,774	2045
37			$277,513	$470,249		$747,761	0.3600	$269,164	2046
38			$277,513	$253,211		$530,723	0.3502	$185,836	2047
39			$225,455	$434,076	$3,136	$662,667	0.3406	$225,717	2048
40			$225,455	$253,211		$478,666	0.3313	$158,602	2049
41			$225,455	$397,903		$623,358	0.3223	$200,918	2050
42			$225,455	$217,038		$442,493	0.3135	$138,738	2051
43			$144,339	$361,730		$506,069	0.3050	$154,350	2052
44			$144,339	$198,951	$3,136	$346,427	0.2967	$102,781	2053
45			$144,339	$325,557		$469,896	0.2886	$135,616	2054
46			$144,339	$198,951		$343,291	0.2807	$96,378	2055
47				$293,001		$293,001	0.2731	$80,019	2056
48				$166,396		$166,396	0.2657	$44,205	2057
49				$293,001	$3,136	$296,137	0.2584	$76,530	2058
50				$148,309		$148,309	0.2514	$37,283	2059
51				$256,828		$256,828	0.2445	$62,805	2060
52				$148,309		$148,309	0.2379	$35,280	2061
53				$256,828		$256,828	0.2314	$59,430	2062
54				$148,309	$3,136	$151,445	0.2251	$34,090	2063
55				$256,828		$256,828	0.2190	$56,237	2064
56				$130,223		$130,223	0.2130	$27,738	2065
57				$220,655		$220,655	0.2072	$45,720	2066
58				$130,223		$130,223	0.2016	$26,247	2067
59				$220,655	$3,136	$223,791	0.1961	$43,878	2068

Table 2-33
Present Value Calculation for CS-10 Groundwater Operable Unit Selected Remedy
(Alternative 10 for the main body and Alternative 3 for the leading edge)

Year	Treatment System Construction & Startup Costs	Baseline Monitoring Costs	O&M	Monitoring	Periodic Costs	Total Cost (0% Discount)	Discount Factor (for 2.8%)	Total Present Value Cost at 2.8%	Calendar Year
60				$130,223		$130,223	0.1907	$24,837	2069
61				$220,655		$220,655	0.1855	$40,939	2070
62				$130,223		$130,223	0.1805	$23,502	2071
63				$220,655		$220,655	0.1756	$38,739	2072
64				$122,988	$3,136	$126,124	0.1708	$21,540	2073
65				$184,482		$184,482	0.1661	$30,648	2074
66				$97,667		$97,667	0.1616	$15,783	2075
67				$159,161		$159,161	0.1572	$25,021	2076
68				$97,667		$97,667	0.1529	$14,935	2077
69				$159,161	$3,136	$162,297	0.1488	$24,143	2078
70				$86,815		$86,815	0.1447	$12,563	2079
71				$122,988		$122,988	0.1408	$17,312	2080
72				$86,815		$86,815	0.1369	$11,888	2081
73				$122,988		$122,988	0.1332	$16,382	2082
74				$86,815	$3,136	$89,951	0.1296	$11,655	2083
75				$122,988		$122,988	0.1260	$15,502	2084
76				$79,581		$79,581	0.1226	$9,757	2085
77				$115,754		$115,754	0.1193	$13,806	2086
78				$79,581		$79,581	0.1160	$9,233	2087
79				$115,754	$3,136	$118,890	0.1129	$13,418	2088
80				$79,581		$79,581	0.1098	$8,737	2089
81				$115,754		$115,754	0.1068	$12,362	2090
82				$68,729		$68,729	0.1039	$7,140	2091
83				$104,902		$104,902	0.1011	$10,601	2092
84				$68,729	$3,136	$71,865	0.0983	$7,065	2093
85				$104,902		$104,902	0.0956	$10,032	2094
86				$68,729		$68,729	0.0930	$6,393	2095
87				$104,902	$78,400	$183,302	0.0905	$16,587	2096
TOTAL	$1,418,463	$20,608	$24,669,293	$33,622,787	$131,712	$59,859,727		$38,407,751	

Table 2-34
Cost Estimate Basis for CS-10 Groundwater Operable Unit Selected Remedy
(Alternative 10 for the main body and Alternative 3 for the leading edge)

ITEM	QUANTITY	UNITS	UNIT COST	TOTAL	SUBTOTAL	COMMENTS
ETR Wellfield Construction Costs						
CAPITAL COSTS						Actual costs provided by AFCEE.
Extraction well installation	1	LS	$ 360,428	$ 360,428		
Reinjection well installation	1	LS	$ 466,879	$ 466,879		
Trench and reinjection pipeline installation	1	LS	$ 350,907	$ 350,907		
Well controls, electrical, and instrumentation	1	LS	$ 118,285	$ 118,285		
Site Restoration	1	LS	$ 111,614	$ 111,614		
Final Survey and Easement Plan	1	LS	$ 10,350	$ 10,350		
TOTAL					$ 1,418,463	
BASELINE GROUNDWATER MONITORING						
CAPITAL COSTS						
Baseline Performance and Environmental Sampling						Two quarters samples collected prior to system startup.
Southern Trench Extraction Well	2	QTR	$ 5,900	$ 11,800		
Baseline Report	1	EA	$ 2,000	$ 2,000		Based on historical experience with similar reports for the MMR project. Report will be included with existing SPEIM documents.
SUBTOTAL					$ 13,800	
OVERHEAD & SUPPORT				$ 4,002		Based on historical experience with similar projects at the MMR site.
TOTAL					$ 17,802	
TOTAL ESCALATED					$ 20,608	Escalated from 2006.
PERIODIC COSTS						
CERCLA 5-YEAR REPORTING						
Report Preparation and Submittal	1	EA	$ 2,000	$ 2,000		Report is part of a larger review of all sources and systems at MMR.
OVERHEAD & SUPPORT				$ 580		
TOTAL					$ 2,580	
TOTAL ESCALATED					$ 3,136	Costs escalated from 2005.
RESIDUAL RISK ASSESSMENT						
Report Preparation and Submittal	1	EA	$ 50,000	$ 50,000		
OVERHEAD & SUPPORT				$ 14,500		
TOTAL					$ 64,500	
TOTAL ESCALATED					$ 78,400	Costs escalated from 2005.

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APPENDIX A

MassDEP Concurrence Letter

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
SOUTHEAST REGIONAL OFFICE
20 RIVERSIDE DRIVE, LAKEVILLE, MA 02347 508-946-2700

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

IAN A. BOWLES
Secretary

LAURIE BURT
Commissioner

August 10, 2009

Mr. James T. Owens III, Director
Office of Site Remediation and Restoration
U.S. Environmental Protection Agency,
New England Office
One Congress Street, Suite 1100
Boston, MA 02114-2023

RE: **BOURNE**
Release Tracking Number: 4-0037
Massachusetts Military Reservation (MMR)
Final Record of Decision for Chemical Spill-10 Groundwater, Concurrence

Dear Mr. Owens:

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the document entitled *Final Record of Decision for Chemical Spill-10 Groundwater* (the ROD), dated July 2009. The ROD was prepared for the Air Force Center for Engineering and the Environment (AFCEE) at the Massachusetts Military Reservation (MMR) in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The ROD presents the selected remedy for the Chemical Spill 10 (CS-10) groundwater plume chosen in accordance with CERCLA. The U.S. Air Force is the lead agency for CERCLA remedial actions at MMR.

The CS-10 groundwater plume is a composite plume comprised of several lobes of contamination originating from multiple source areas on MMR. The main source area for the CS-10 groundwater plume is the former Boeing Michigan Aerospace Research Center (BOMARC) facility located at MMR, which includes the Unit Training Equipment Site (UTES). Numerous other sources of contamination are presumed to have contributed to the CS-10 plume as it migrated underneath the cantonment area of MMR. The contaminants of concern (COCs) in the CS-10 plume are the chlorinated solvents tetrachloroethene (PCE) and trichloroethene (TCE). The CS-10 plume consists of two primary components; the main body of the CS-10 plume located on the MMR underneath the cantonment area in the southern portion of the MMR in Sandwich, and the CS-10 leading edge, which consists of three lobes of groundwater contamination located off the MMR in the towns of Falmouth and Mashpee. The main body of the CS-10 groundwater plume is nearly three miles long and extends from approximately ½ mile south of the former UTES/BOMARC facility on the MMR to Sandwich Road along the western shore of Ashumet Pond. The CS-10 leading edge is comprised of the Northern Lobe (NL), the North Central Lobe (NCL) and the Southern Lobe (SL). These lobes are located downgradient of the existing CS-10 Sandwich Road extraction/reinjection fence, which is located just upgradient of the northwest shoreline of Ashumet Pond. The NL and NCL plumes have migrated beneath Ashumet Pond and Johns Pond in Falmouth and Mashpee.

This information is available in alternate format. Call Donald M. Gomes, ADA Coordinator at 617-556-1057. TDD# 866-539-7622 or 617-574-6868.

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In September 1995, a *Final Record of Decision for Interim Action, Containment of Seven Groundwater Plumes at Massachusetts Military Reservation, Cape Cod, Massachusetts* (IROD) was signed by the Department of Defense and the EPA, with concurrence from MassDEP. The IROD remedial design for the CS-10 plume was modified through extensive public participation. After consideration of input from the public, a remedial alternative was selected that involved installing an axial extraction, treatment and reinjection (ETR) system along Sandwich Road to prevent the main body of the CS-10 plume from migrating beneath Ashumet Pond and additional extraction wells within the main body of the CS-10 plume to accelerate mass capture. The IROD also committed AFCEE to further investigation of the leading edge of the CS-10 groundwater plume in the area downgradient of Sandwich Road and the northwest shoreline of Ashumet Pond. Several leading edge lobes of the CS-10 plume were delineated in 1999 under Ashumet Pond and between Ashumet and Johns Ponds. Due to the high concentrations of TCE detected within the NL and the discharge of the NL into Johns Pond, remediation of the NL proceeded under a time-critical removal action. Remediation of the NL commenced in January 2000 with startup of one extraction well.

The Sandwich Road Treatment Facility (SRTF), which began operation in May 1999, consisted of eight extraction wells and six reinjection wells. Two extraction wells have been turned off as a result of system optimization. The extracted groundwater is processed through granular activated carbon (GAC) units located on MMR. The extracted groundwater is piped to the GAC units, and the treated water is returned to the aquifer through reinjection wells. The CS-10 In-Plume groundwater remedial system began operating in June 1999 and consisted of eight additional extraction wells and two infiltration trenches. The contaminated water is processed through GAC units at the CS-10 In-Plume treatment plants. An additional extraction well was added to the CS-10 In-Plume system in 2004 to improve capture of the CS-10 plume between the southern infiltration trench and the Sandwich Road extraction fence.

The selected final remedy for the CS-10 groundwater plume consists of *continued monitoring and active treatment* of the CS-10 groundwater plume with the existing treatment components, plus *expansion of the system* to improve capture of the CS-10 groundwater plume downgradient of the southern infiltration trench. The treatment system expansion involves the installation of an additional extraction well and reinjection well in the uncaptured portion of the plume on the west side of Ashumet Pond. Contaminated groundwater removed from the aquifer by the new extraction well will be treated at the SRTF and returned to the aquifer via reinjection wells. Operation of the new remedial components began in February 2009. The final remedy also includes *land use controls* (LUCs) to reduce human exposure to contaminated groundwater. LUCs have already been implemented by AFCEE to prevent access to or use of the groundwater from the CS-10 plume until the groundwater no longer poses an unacceptable risk to human health. Monitoring of the LUCs will be conducted annually by AFCEE. Additionally, AFCEE will submit an annual monitoring report to the regulatory agencies that will evaluate the status of the LUCs and how any identified deficiencies and/or inconsistent uses have been addressed.

The final remedy will ensure a sufficient level of control for the CS-10 groundwater plume such that none of the contamination associated with the plume will present a significant risk of harm to health, safety, public welfare or the environment during any foreseeable period of time. Moreover, the remedy has been designed to reduce the level of contaminants to background levels, consistent with the Massachusetts Contingency Plan (MCP). The majority of public comments support the selected remedy.

MassDEP concurs with the selected remedy as presented in the final ROD. MassDEP's concurrence is based upon representations made to MassDEP by the AFCEE and assumes that all information provided is substantially complete and accurate. Without limitation, if MassDEP determines that any material omissions or misstatements exist, if new information becomes available, if LUCs are not properly implemented,

monitored and/or maintained or if conditions within the CS-10 groundwater plume change, resulting in potential or actual human exposure or threats to the environment, MassDEP reserves its authority under M.G.L. c. 21E, and the MCP, 310 CMR 40.0000 et seq., and any other applicable law or regulation, to require further response actions.

Please incorporate this letter into the Administrative Record for the Chemical Spill-10 groundwater plume. If you have any questions regarding this matter, please contact Leonard J. Pinaud, Chief, Federal Facilities Remediation Section, at (508) 946-2871 or Millie Garcia-Serrano, Deputy Regional Director of the Bureau of Waste Site Cleanup at (508) 946-2727.

Sincerely,

Laurie Burt
Commissioner
Massachusetts Department of Environmental Protection

LB/lp

MassDEP CS-10 ROD Concurrence letter.doc

ec: David Johnston, Acting Regional Director
Millie Garcia-Serrano, Deputy Regional Director
Leonard J. Pinaud, Chief, Federal Facilities Remediation Section
Rebecca Tobin, Regional Counsel
MassDEP Southeast Region
Janine Commerford, Assistant Commissioner, BWSC
MMR Senior Management Board
MMR Plume Cleanup Team
Upper Cape Boards of Selectmen
Upper Cape Boards of Health

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APPENDIX B

Transcript of Public Hearing

MASSACHUSETTS MILITARY RESERVATION

AIR FORCE CENTER FOR ENGINEERING
AND THE ENVIRONMENT

Public Hearing on:

Chemical Spill 10 Groundwater Proposed Plan

Barnstable County Fairgrounds
Administration Building
Route 151
East Falmouth, Massachusetts 02536

HEARING OFFICER: Douglas Karson, AFCEE

Thursday, February 5, 2009
6:30 p.m.

Carol P. Tinkham
Professional Court Reporter
321 Head of the Bay Road
Buzzards Bay, MA 02532
(508) 759-9162
caroltinkham@gmail.com

A T T E N D E E S:

Douglas Karson - Mass. Military Reservation

David Dow - Sierra Club

Michael Minior - Air National Guard

Lynne Jennings - USEPA

Paul Marchessault - USEPA

Katherine Thomas - Jacobs Engineering

Len Pinaud - MassDEP

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P R O C E E D I N G S

HEARING OFFICER KARSON: Good evening. The Official Record is now open for this public hearing on the Proposed Plan for Groundwater at Chemical Spill 10.

My name is Douglas Karson, Community Involvement lead for the Installation Restoration Program at the Massachusetts Military Reservation. I am the hearing officer here tonight.

The purpose of this hearing is to accept oral and written comments on the Air Force's Proposed Plan for groundwater at Chemical Spill 10. There are copies of the Proposed Plan on the table.

All oral comments that are received tonight will be transcribed verbatim. Those comments, along with any comments submitted in writing tonight and during the comment period, will become part of the official record on this project. AFCEE and the regulatory agencies will consider all comments prior to making a final decision. Each and every comment will be responded to in a Responsiveness Summary that will be issued at a later date as part of the Record of Decision. The Record of Decision will contain the Air Force's final decision for the Chemical Spill 10 Groundwater Plume.

1 This hearing is exclusively for listening to
2 and recording your oral comments. I will not
3 respond to your comments during the hearing unless
4 you need clarification on something. I may ask you
5 for clarification if I am not sure what your comment
6 is. You can also provide written comments to me at
7 any time tonight. Everyone wanting to make an oral
8 comment must state their name and town of residence.
9 The floor is now open for public comment.
10 MR. DOW: This is David Dow. I live in East
11 Falmouth, Massachusetts and I'm here representing
12 the Cape Cod and Islands Group of the Sierra Club.
13 We favor Alternative 10 for the main plume body and
14 Alternative 5 for the leading edge, which would
15 include active treatment for the leading edges of
16 the North Central Lobe and the Southern Lobe. And
17 of course there's an extraction system in place
18 already for the Northern Lobe and there's a Sandwich
19 Road treatment fence and treatment plant for the
20 main body of the plume and also it'll deal with the
21 new Southern Trench well.
22 So, we agreed with the Air Force Center for
23 Engineering and the Environment on the Alternative
24 10 part but we favor Alternative 5 over Alternative
25 3 for the leading edge. The reason that we opted

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1 for Alternative 5 is that we felt there was a lot of
2 uncertainty about whether the North Central Lobe and
3 Southern Lobe leading edges would reach east of
4 John's Pond, and given that uncertainty in the model
5 we felt that following the precautionary principle
6 it would be best to have active treatment for the
7 leading edges of the North Central Lobe and the
8 Southern Lobe.
9 The other thing that we recommended in our
10 comments, which I actually e-mailed before I came
11 over, was that they have an independent group to
12 evaluate the modeling of the future scenarios of
13 whether the Southern Lobe and the North Central Lobe
14 leading edges will actually extend to the east of
15 John's Pond and not be either naturally attenuated
16 or trapped by the fine grade sediments that lie
17 underneath John's Pond. So that was one of the
18 suggestions we had to -- based on what was in the
19 proposed plan and the supporting information that's
20 been recently provided to the public by the AFCEE.
21 So that's the extent of my comments.
22 HEARING OFFICER KARSON: Thank you, Mr. Dow.
23 Are there any further comments to be offered at
24 this time from anyone?
25 [Pause.]

HEARING OFFICER KARSON: If there are no further comments to be made, then please note that you can still provide written comments through tomorrow, February 6th.

I shall now close the public hearing for the Proposed Plan for Groundwater at Chemical Spill 10. Thank you all for coming.

[Whereupon, this matter ended at 6:35 p.m..]

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C E R T I F I C A T E

COMMONWEALTH OF MASSACHUSETTS
COUNTY OF BARNSTABLE

I, Carol P. Tinkham, a Professional Court Reporter and Notary Public in and for the Commonwealth of Massachusetts, do hereby certify that the foregoing transcript represents a complete, true and accurate transcription of my audiographic recordings taken in the matter of Massachusetts Military Reservation AFCEE Public Hearing on Chemical Spill 10 Groundwater Proposed Plan, heard at the Barnstable County Fairgrounds Administration Building on Thursday, February 5, 2009.

Carol P. Tinkham
Notary Public
My Commission Expires
May 14, 2010

PLEASE NOTE: THE FOREGOING CERTIFICATION OF THIS TRANSCRIPT DOES NOT APPLY TO ANY REPRODUCTION OF THE SAME BY ANY MEANS UNLESS UNDER THE DIRECT CONTROL AND/OR DIRECTION OF THE CERTIFYING REPORTER.

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APPENDIX C

Falmouth Board of Health Well Regulations

Falmouth Board of Health

Water Well Regulations

Purpose

The Falmouth Board of Health recognizes that certain areas of the groundwater aquifer beneath Falmouth have been contaminated by activities associated with the Massachusetts Military Reservation and others, and that not all areas of groundwater contamination have been identified. There are risks associated with exposure to these contaminants through direct ingestion, dermal contact, inhalation, irrigation of food crops, or watering of animals that are later to be consumed.

In order to protect the public from exposure to potentially contaminated groundwater, the Falmouth Board of Health adopts the following regulations for the permitting, installation and use of water wells, under the authority of Massachusetts General Laws Chapter 111, Section 30.

The testing requirements herein reflect prudent means of minimizing, but not eliminating the risk from exposure to groundwater contamination. Persons withdrawing water for drinking or irrigation are encouraged to stay informed about newly identified contaminants that may be contained in the groundwater they use, and to exercise prudence in all aspects of water withdrawal.

Section 1. Definitions:

A. Drinking Water Well - Any private source of groundwater for human use, including but not limited to, a source approved for such by the Falmouth Board of Health or Massachusetts Department of Environmental Protection (DEP) in accordance with MGL 11 sec 122A or 310 CMR 22.00.

B. Irrigation Well - Any water supply well not approved as a drinking water supply used for the watering of plants and livestock or for commercial or industrial use.

C. Monitoring Well - A well installed for the expressed purpose of monitoring water quality or water level in an area. Excluded from these requirements are wells less than twenty feet deep used for purposes of determining groundwater elevations associated

with the installation of a septic system and which are removed at the time of septic system installation or when they are no longer needed.

D. Volatile Organic Compounds - The class of organic compounds detected and quantified using United States Environmental Protection Agency (EPA) Methods 502.2, 502.4, 624.0, and 625 and 504 (modified for the analysis of Ethylene Dibromide (EBD) to a detection limits of 0.02 ug/l or 2.0 parts per billion).

Section 2. Permits Required:

A permit from the Board of Health shall be required for the installation and use of all wells, including Drinking Water Wells, Irrigation Wells, and Monitoring Wells within the Town of Falmouth. A permit granted under these regulations will that is not exercised within one year may be renewed annually for up to two additional years.

A) Drinking Water Well - A permit application for a Drinking Water Well shall include: a plan of the lot on which the Drinking Water Well is to be located showing the location of any septic systems within 150 ft of the proposed well, the location of the house or any permanent structures (existing or proposed), and a description of the proposed well that includes the location, construction material, anticipated depth of the well, and the maximum anticipated withdrawal rate in gallons per minute. The application shall also include proof that all abutters within 100 feet of the property line have been notified by receipted mail using a form of letter approved by the Board of Health. In the case of new construction, well location and description may be shown on the same plan submitted under the requirements for the Board of Health approval of the septic system. Replacement of a Drinking Water Well within 5 feet of the original location shall not require a permit under these regulations.

B) Irrigation Well - A permit application for an Irrigation Well shall include a plan of the lot on which the Irrigation Well is to be located that shows the location of any septic systems or water supply wells within 150 ft of the proposed Irrigation Well, the location of the house or any permanent structure(s) (existing or proposed), and a description of the proposed well that includes the location, construction material, anticipated depth of the well, an the maximum anticipated withdrawal rate in gallons per minute and all proposed faucets and discharge points. This permit does not relieve the applicant from being

required to secure any and all additional permits that may be required by the State under the Water Management Act or any other pertinent regulation.

C) Monitoring Well - A permit for a Monitoring Well shall include an exact location at which the Monitoring Well is to be located in degrees latitude and longitude, a description of the Monitoring Well that includes the construction material and depth, a statement of purpose for which the Monitoring Well is being installed and its proposed length of service. The name, address, and telephone number of a contact person shall be included in the application. Permits for monitoring wells shall be granted for a period requested or any period deemed appropriate by the Board of Health.

Section 3. Requirements for use.

A. Drinking Water Wells - All Drinking Water Wells shall be located: 1) to maintain a minimum lateral distance from the well to the nearest septic system of 100 ft., 2) to provide minimum risk of exposure to contamination from any known or suspected source, and 3) so that they do not infringe upon the ability of adjacent property owners to locate septic systems. No Drinking Water Well shall be physically connected with a public water supply line. A Drinking Water Well must tested for coliform, nitrate-nitrogen, and volatile organic compounds and found to be within potable water limits as defined in 310 CMR 22.000 Drinking Water Regulations and must not exceed the Commonwealth of Massachusetts' Maximum Contaminant Levels. The Board of Health, by this regulation reserves the right to require more extensive testing in areas of known or suspected contamination. A Drinking Water Well shall not be used until an as-built plan and the results of all required testing have been submitted and approved by the Board of Health.

B) Irrigation Wells - Irrigation Wells shall be located: 1) to maintain a minimum lateral distance from the well to the nearest septic system of 50 ft, 2) a minimum of 50 ft. from a lot line, and 3) to provide minimum risk of exposure to contamination from any known or suspected source. No irrigation well shall be physically cross-connected with the plumbing of either a drinking water well or a public water supply line. All irrigation well spigots shall be placarded with a notice that reads "Irrigation Well - Not for Drinking Water Purposes". Spigots for Irrigation Wells shall not be attached to a residence. An Irrigation Well shall not be used until: 1) an as-built plan and the results of all required testing have been submitted and approved by the Board of Health, and 2) A notice of the

existence and location of an irrigation well shall be recorded with the Barnstable County Registry of Deeds. In areas of known or suspected contamination, such as exist in certain areas near the Massachusetts Military Reservation, initial tests of Irrigation Wells for volatile organic compounds shall be required prior to use. Irrigation Wells must not exceed the Maximum Contaminant Levels set forth in 310 CMR 22.00 for volatile organic compounds referred to in section 1D.

C) Monitoring Wells - All Monitoring Wells shall have a locking cap or other device or structure to prevent unlawful use or entry. Caps shall be secure at all times when the well is not in use.

Section 4. Conversion of Irrigation Wells:

Water from an Irrigation Well shall not be used as a drinking water well until it is demonstrated that: 1) the water meets all the requirements of potability (Section 3A) ; 2) the well meets all the requirements of a Drinking Water Well relative to setbacks from septic systems and other potential sources of contamination; 3) the use of a well for such purposes shall not infringe upon the rights of all adjacent property owners to construct or replace their septic systems, and; 4) the well is permitted as a Drinking Water Well.

Section 5. Abandonment of Wells

A) Drinking Water Wells - A Drinking Water Well may be abandoned by: 1) Downgrading it to the classification of an Irrigation Well, or 2) Permanently taking it out of service by disconnecting it from the residential drinking water system and sealing it with concrete followed by notice and inspection by the Falmouth Board of Health. Downgrading a Drinking Water Well to an Irrigation Well requires that the well meet all the requirements denoted in Section 3 B.(Irrigation Wells).

B) Irrigation Well - An Irrigation Well may be abandoned by filling the entire pipe volume with concrete, followed by a notice and inspection by the Falmouth Board of Health and recording said abandonment with the Registry of Deeds.

C) Monitoring Well - A Monitoring Well may be abandoned by filling the entire pipe volume with concrete, followed by a notice and inspection by the Falmouth Board of Health, or removal of the entire length of pipe from the ground.

Section 6. Enforcement

This regulation will be enforced by the Board of Health under the authority granted it under MGL Chapter 111, Section 30.

These regulations are adopted on September 13, 1999 and become effective on the date of publication:

Dr. Albert Price, Chairman

Robert Chausse

Robert Chausse

George Heufelder

Arthur Vidal III

John Waterbury

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APPENDIX D

Mashpee Board of Health Well Regulations

TOWN OF MASHPEE
BOARD OF HEALTH

PUBLIC WATER SUPPLY REQUIREMENTS

Under the authority of the Massachusetts General Laws, Chapter 111, Section 31, the Board of Health has adopted the following regulation in an effort to better protect the public health of the residents of Mashpee:

Whereas, there are known and documented areas of groundwater contamination within the Town of Mashpee and;

Whereas, there may be future areas of groundwater contamination unknown at present;

Therefore, the Board of Health, at its discretion, may require single family, multi-family or commercial structures to connect to a community public water supply.

This regulation is adopted by the Board of Health on September 13, 1990 and shall be come effective upon the date of publication.

Per Order Of,
The Mashpee Board of Health

Stephen J. Greelish, Chairman
John T. Doherty, Co-Chairman
George R. Costa, Clerk

TOWN OF MASHPEE
BOARD OF HEALTH

MORATORIUM ON GROUNDWATER WELLS

Under the authority of Massachusetts General Laws, Chapter 111, Section 31, the Board of Health of Mashpee adopts the following regulation in an effort to better protect the public health and welfare of the citizens and visitors in the Town:

REGULATION:

Residential well located in documented or anticipated areas of groundwater contamination as defined by the Board of Health are herewith restricted from use for any purpose, including drinking, any agricultural use (lawn watering, gardening, livestock watering, irrigation of crop land, etc.), washing vehicles, pool filling, etc. This moratorium includes groundwater wells owner by residents currently connected to a public water supply.

A Massachusetts Licensed Well Driller must decommission the affected wells and written evidence thereof must be submitted to the Board of Health.

PURPOSE:

This regulation seeks to prevent any inadvertent exposure to contaminated groundwater, which may present a potential health risk to the residents and visitors of Mashpee. Residential well waters in documented or potentially affected areas of groundwater pollution pose a possibility of exposure pathways to humans. Ingestion, inhalation and dermal exposure are potential pathways. This potential risk necessitates this regulation.

Adopted by the Board of Health on April 23, 1998. This regulation will become effective upon the date of publication in the press.

Per Order Of,
The Mashpee Board of Health

Steven R. Ball, Chairman
John T. Doherty, Co-Chairman
Robert F. Cram, Clerk

TOWN OF MASHPEE
BOARD OF HEALTH

AMENDMENT TO MORATORIUM ON GROUNDWATER WELLS

Under the authority of Massachusetts General Laws, Chapter 111, Section 31, the Board of Health of Mashpee adopts the following regulation in an effort to better protect the public health and welfare of the citizens and visitors in the Town:

REGULATION:

Existing and future residential wells located in documented or anticipated areas of groundwater contamination as defined by the Board of Health are herewith restricted from use for any purpose, including drinking, any agricultural use (lawn watering, gardening, livestock watering, irrigation of crop land, etc.) washing vehicles, pool filling, etc. This moratorium includes groundwater wells owner by the residents currently connected to a public water supply.

A Massachusetts Licensed Well Driller must decommission the affected wells and written evidence thereof must be submitted to the Board of Health.

PURPOSE:

This regulation seeks to prevent any inadvertent exposure to contaminated groundwater, which may present a potential health risk to the residents and visitors of Mashpee. Residential well waters in documented or potentially affected areas of groundwater pollution pose a possibility of exposure pathways to humans. Ingestion, inhalation and dermal exposure are potential pathways. This potential risk necessitates this regulation.

Adopted by the Board of Health on April 23, 1998. This regulation will become effective upon the date of publication in the press.

THE BOARD OF HEALTH

The original intent of the Board of Health was clarified on July 15, 1999, by inserting the words **"Existing and Future"** in the first paragraph of the regulation. The Board of Health approved this amendment to the regulation on July 29, 1999.

Per Order Of,
The Mashpee Board of Health

Steven R. Ball, Chairman
John T. Doherty, Co-Chairman
Robert F. Cram, Clerk

JACOBS

6 Otis Park Drive
Bourne, MA 02532-3870 U.S.A.
1.508.743.0214 Fax 1.508.743.9177

31 August 2009

Mr. Jonathan S. Davis
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road
Otis ANG Base, MA 02542-5028

SUBJECT: Contract F41624-03-D-8605
MMR Plume Response Program
TO 0002 DCN/PROJECT # A4P-J23-35BC02VA-M26-0018
Final Record of Decision for Chemical Spill-10 Groundwater

Dear Mr. Davis:

As directed by the Air Force Center for Engineering and the Environment, Jacobs is providing seven bound copies, one unbound copy, and ten compact discs of the above-referenced document. Copies are also being sent to the appropriate agencies.

Please feel free to contact me at (508) 743-0214, extension 265, or Katie Thomas at (508) 743-0214, extension 224, if you have any questions or comments. Mr. Mike Minior is the Air Force point of contact for this project and may be reached at (508) 968-4670, extension 4672.

Sincerely,

Anita Rigassio Smith
Program Manager

ARS/sc

Enclosures: Document (7 bound, 1 single-sided unbound, & 10 CDs)

c: HQ AFCEE/ACB (w/o attach)
HQ AFCEE/MSCD (w/o attach)
Rose Forbes, AFCEE (1)
Paul Marchessault, EPA (1, 1 CD)
Jim Murphy, EPA (w/o attach)
Leonard Pinaud, MassDEP (1, 1 CD)
Ellie Grillo, MassDEP (w/o attach)
Mike Ciaranca, E&RC (c/o IRP, 1 CD)
Hopeton Brown, SFIM-AEC-CDP (1 CD)
Peter Golonka, GF (1, 1 CD)
James Quin, Goshawk Corporation, Inc. (1)
Denis LeBlanc, USGS (1, 1 CD)
Andrew McManus, Consv. (Mashpee) (1)
Glenn Harrington, LBH (Falmouth) (1)
Robert Buchsbaum, Mass Audubon Society (1)
Nigel Tindall, CH2MHill (1)
Anita Rigassio Smith, Jacobs (1)
Katie Thomas, Jacobs (1)
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