Massachusetts Military Reservation

Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-13, Fuel Spill-28, and Fuel Spill-29 Groundwater Plumes

September 2008

Prepared for:
AFCEE/MMR
Installation Restoration Program
322 E. Inner Road
Otis ANGB, MA 02542

Prepared by:
Jacobs Engineering Group Inc.

Document No.: A4P-J23-35BC24VC-M26-0006

TABLE OF CONTENTS

TABLE OF CONTENTS

Figures

Appendixes

ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Engineering and the Environment
BOH	board of health
CCl_4	carbon tetrachloride
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)
CFR	Code of Federal Regulations
COC	contaminant of concern
CS-4	Chemical Spill-4
CS-20	Chemical Spill-20
CS-21	Chemical Spill-21
EDB	ethylene dibromide
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
ETR	extraction, treatment, and reinjection
FFA	Federal Facility Agreement
FS-13	Fuel Spill-13
FS-28	Fuel Spill-28
FS-29	Fuel Spill-29
GAC	granular activated carbon
gpm	gallons per minute
IRP	Installation Restoration Program
LUCs	land use controls
MassDEP	Massachusetts Department of Environmental Protection
MCL	maximum contaminant level

MMCL	Massachusetts maximum contaminant level

ACRONYMS AND ABBREVIATIONS

MMR	Massachusetts Military Reservation
NCP	National Contingency Plan
NPL	National Priorities List
PCE	tetrachloroethene
PCT	Plume Cleanup Team
RI	remedial investigation
ROD	Record of Decision
SWOU	Southwest Operable Unit
TCE	trichloroethene
µg/L	micrograms per liter
1,1,2,2-TeCA	1,1,2,2-tetrachloroethane

1.0 INTRODUCTION

This Explanation of Significant Differences (ESD) has been prepared to document changes to the selected remedy for the Chemical Spill-4 (CS-4), Chemical Spill-20 (CS-20), Chemical Spill-21 (CS-21), Fuel Spill-29 (FS-29), Fuel Spill-28 (FS-28), and Fuel Spill-13 (FS-13) groundwater plumes. The Records of Decision (RODs) that prescribe the cleanup strategy for these plumes were signed in February 2000 (CS-4, CS-20, CS-21, and Fuel Spill-13) and October 2000 (FS-29 and FS-28). The RODs indicate that the Air Force Center for Engineering and the Environment (AFCEE) will remediate the groundwater contamination in the CS-4, CS-20, CS-21, FS-28, and FS-29 groundwater plumes by extracting contaminated groundwater from the plumes using extraction wells and shallow well-points, piping the contaminated water to treatment plants where filtration through granular activated carbon (GAC) will remove the plume contaminants, and piping the treated water to infiltration galleries and surface water bubblers that return the water to the aquifer and to surface water bodies. The selected remedy for the FS-13 plume was long-term monitoring; no treatment would be performed. Since the RODs were finalized in 2000, AFCEE has collected additional environmental data that have improved the understanding of the CS-4, CS-20, CS-21, and FS-29 plume characteristics, and has used these data to support a detailed design of the groundwater extraction, treatment, and reinjection (ETR) systems that will clean up these plumes. The significant difference between the cleanup strategy identified in the RODs and the current design is that the RODs anticipated that all of the groundwater within the CS-4, CS-20, and FS-29 plumes would be captured by the ETR systems, but the final designs will allow the groundwater contamination in the downgradient leading edges of the plumes to reach cleanup levels through natural attenuation instead of through active remediation. The portions of the CS-4 and FS-29 plumes that would not be captured by the ETR system are characterized by low concentrations and would result in poor extraction system performance. The leading edge of the FS-29 plume is also located in an area of significant topographic relief, which would pose significant implementability challenges for construction of an extraction system in that area. The CS-20 cleanup strategy was modified because access to private property could not be attained for appropriate placement of a leading edge extraction well. The FS-28 remedial system has

been modified since the ROD was signed in 2000 but the modifications are consistent with the cleanup strategy outlined in the ROD (AFCEE 2000a); the modifications are not considered a significant difference from the selected remedy. The plumes and cleanup strategies are further discussed in Sections 2 and 3. There are only minor changes to wording of the CS-21, FS-13, and FS-28 plume remedies.

The following two RODs are amended by this ESD:

- *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes* (AFCEE 2000b)

Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes (AFCEE 2000a).

1.1 STATEMENT OF PURPOSE

AFCEE is issuing this ESD in accordance with 40 Code of Federal Regulations (CFR) Section 300.435(c)(2)(i) and Section 300.825(a)(2) of the National Contingency Plan, which requires the publication of an ESD to describe the significant difference(s) between the selected remedial action and the modified remedial action, including an explanation of why such changes were made. This ESD will become part of the Administrative Record for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes at the Massachusetts Military Reservation (MMR). The Administrative Record is available for public review at www.mmr.org.

1.2 AUTHORIZING SIGNATURES

The following signatures represent the decision to authorize this ESD.

U.S. AIR FORCE

Date: 25 Sep 08

KEITH F. YAKTUS, Colonel, USAF
Executive Director
Air Force Center for Engineering and the Environment

U.S. ENVIRONMENTAL PROTECTION AGENCY

Date: 9-26-08

JAMES T. OWENS III
Director
Office of Site Remediation and Restoration

(Intentionally blank)

2.0 SITE HISTORY, SITE CONTAMINATION, AND SELECTED REMEDY

This section presents background information on the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes, including an overview of the physical and chemical characteristics, history, and selected remedies for these plumes.

2.1 SITE LOCATION AND HISTORY

The plumes originated from chemical and fuel spills on the MMR. The MMR, listed on the National Priorities List (NPL) as Otis Air National Guard/Camp Edwards, lies within the towns of Bourne, Mashpee, and Sandwich and abuts the town of Falmouth, Massachusetts (Figure 2-1). The CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 groundwater plumes are located in western Cape Cod, within the MMR and in the town of Falmouth, Massachusetts (Figure 2-2). The MMR site was assigned identification number MA2570024487 in the U.S. Environmental Protection Agency's (EPA) Comprehensive Environmental Response, Compensation, and Liability Information System. In accordance with Executive Order 12580, the U.S. Department of Defense is the lead agency for remedial actions at the MMR. The EPA and the Massachusetts Department of Environmental Protection (MassDEP) are the support agencies for this action. The MMR was formally added to the NPL in 1989. A Federal Facility Agreement (FFA), which provided the legal framework for investigating and remediating numerous operable units at the MMR, was signed in 1991 (EPA et al 1991). In 1996, the FFA was amended to add the U.S. Air Force as the lead agency for the cleanup at MMR. The FFA, as amended, requires the U.S. Air Force to implement Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) requirements at MMR.

The MMR comprises approximately 20,000 acres on Cape Cod and provides facilities for several operating command units: the Air National Guard, the Army National Guard, the Air Force, the U.S. Coast Guard, and the Veterans Affairs. Past military training, maneuvers, aircraft operations, maintenance and support activities at the MMR have

resulted in releases of hazardous materials that generated plumes of contaminated groundwater in the unconfined sand and gravel aquifer that underlies western Cape Cod.

For the CS-4 plume, environmental investigations began in 1986, and active groundwater remediation began in 1993 under an interim ROD signed in 1992. The remedial system consisted of a fence of 13 extraction wells at the leading edge of the plume. With a total extraction rate of 120 gallons per minute (gpm), they pumped water to a GAC filtration system located on the MMR and returned the treated water to the aquifer through two infiltration trenches also on the MMR. However, after a few years of operation it became apparent that the ETR system was not performing as designed because the plume extent was greater than originally characterized (i.e., a portion of the plume was below and outside of the extraction well fence capture zone). The extraction wells operated until August 2002 and were abandoned in January 2004. The plant was decommissioned in February 2004.

Environmental investigations of the FS-28 plume began in 1992, and active groundwater remediation began in 1997 under a time critical response action (AFCEE 1998) which was later modified as part of a non-time critical removal action (AFCEE 1999a). The remedial system consisted of one extraction well and multiple shallow well points to extract contaminated water, which was treated with GAC filtration, and returned to the Coonamessett River through surface water bubblers. The remedy also provided all private well users in the immediate vicinity of the plume with connections to municipal water supplies, provided surface water agricultural users with clean water, and separated the Coonamessett River from the surrounding cranberry bogs through the use of berms and sheet piles. Additionally, a GAC filtration system was installed at the Coonamessett Water Supply Well to protect this public water supply. In 2007 the FS-28 remedial system was expanded through installation of an additional extraction well to remediate the deeper leading edge lobe identified south of the existing extraction well and shallow well points (AFCEE 2008b) (Figure 2-2).

A site investigation of the FS-13 plume was conducted in 1995, followed by a remedial investigation (RI) field program (1996) consisting of drilling and groundwater sampling

(Stone & Webster 1997). The evaluation of nature and extent of contamination and risk assessment was conducted as part of a regional RI discussed below. Long-term monitoring of the plume indicates the plume contaminants are not mobile and have not migrated (AFCEE 2005b).

In 1998, AFCEE conducted a regional RI that comprehensively investigated groundwater and surface water quality in an area identified as the Southwest Operable Unit (SWOU). The SWOU study area included areas with known plumes (including the CS-4, FS-13, and FS-28 plumes), suspected plumes, and previously uninvestigated areas. The CS-20, CS-21, and FS-29 plumes were discovered during the 1998 SWOU RI. Feasibility studies for the six groundwater plumes in the SWOU [CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29] were conducted in 1999 (AFCEE 2000d, 1999b). After formal public comment periods were held in 1999 and 2000 on AFCEE's proposed plans for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes, the two aforementioned RODs were signed in 2000 (AFCEE 2000c, 1999c). The collection of additional data needed to support remedial system design for the CS-4, CS-20, CS-21, and FS-29 plumes began in 2000 and ended in 2002. Engineering design work for the remediation systems began in 2002, and system construction began in 2004. The remedial systems consist of extraction in each plume, treatment at the Hunter Avenue Treatment Facility, and reinjection or infiltration located next to the plumes (Figure 2-2). The new CS-4 system began operation in November 2005. The CS-20 system began operation in January 2006. The FS-29 and CS-21 systems began operation in September 2006.

2.2 GROUNDWATER PLUME CHARACTERISTICS

The understanding of the nature and extent of the plumes is revised with time as groundwater quality data are periodically collected and analyzed. A thorough discussion of the CS-4, CS-20, CS-21, and FS-29 plumes based on the findings from the pre-design field investigation activities conducted between April 2000 and November 2002 is provided in the *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-29 Pre-Design Investigation Report* (AFCEE 2003). The plumes are summarized below based on the fundamental characterization of the plumes made in the pre-design

investigation report (AFCEE 2003) and supplemented with data collected through 2006 to further characterize the leading edge of the CS-20 plume and to support system performance assessment for all four of the plumes. The most recent descriptions of the FS-28 and FS-13 plumes are provided in the FS-28 annual summary letter report (AFCEE 2008b) and the FS-13 data transmittal (AFCEE 2005b), respectively.

2.2.1 CS-4 Plume

The CS-4 plume is approximately 4,900 feet long and a maximum of 800 feet wide (Figure 2-2). Groundwater samples between the source area and trailing edge of the CS-4 plume indicate that it has detached from its source area. The CS-4 source area was remediated through several excavation and disposal efforts (AFCEE 2005a). EPA has eliminated the CS-4 source area from the National Priorities List per the Notice of Partial Deletion of Sites at the Otis ANG/Camp Edwards Superfund Site issued on 26 October 2007. The CS-4 plume outline is based on tetrachloroethene (PCE) concentrations greater than the PCE maximum contaminant level (MCL) of 5 micrograms per liter (µg/L). Trichloroethene (TCE) (MCL of 5 µg/L) and 1,1,2,2-tetrachloroethane (1,1,2,2-TeCA) concentrations greater than the Groundwater-1 standard of 2 µg/L are co-located with PCE concentrations greater than the MCL. The current (2005 and 2006) maximum PCE concentration within the CS-4 plume is 23.5 µg/L, with the higher concentrations centered in the middle of the plume. The current maximum TCE concentration is 7.4 µg/L and the 1,1,2,2-TeCA concentration is 5.3 µg/L.

Groundwater within the CS-4 plume is flowing in a southerly direction with an approximate groundwater velocity of one foot per day in the sand portions of the aquifer. When the interim CS-4 extraction fence was operational, it intercepted the shallowest part of the plume; but most of the plume lies beneath the elevation of the fence. Downgradient of the former CS-4 extraction fence, the plume becomes less thick and less wide. The CS-4 plume is up to 100 feet thick and the top of the plume is approximately 110 ft below the ground surface and 60 feet below the water table. The total mass of PCE in the CS-4 2006 plume shell is estimated to be 25.1 pounds (lbs) based on the data from 2003 through early 2006.

2.2.2 CS-20 Plume

The CS-20 plume is a detached plume. The source of the CS-20 plume has not been identified. All potential source areas upgradient of the CS-20 plume were investigated and remediated, if necessary, through the Installation Restoration Program (IRP). The plume is approximately 7,500 feet long and a maximum of 1,200 feet wide (Figure 2-2). The CS-20 plume was previously defined primarily by concentrations of PCE greater than the MCL and secondarily by TCE greater than the MCL. Currently the CS-20 plume is only defined by PCE (in 2006 the TCE concentrations decreased below the MCL). The PCE concentrations within the CS-20 plume range from none detect to 98.1 µg/L, with the higher concentrations located in the downgradient portion of the plume. Additional groundwater data collected in 2005 along Boxberry Hill Road and Goeletta Drive provided more information on the characterization of the downgradient portions of the upper and lower lobes of the plume. Downgradient of Route 151, the plume is defined primarily by an upper lobe with the highest PCE concentrations within the plume (98.1 µg/L) detected along Boxberry Hill Road. Downgradient of Route 151 the lower lobe has only been detected at concentrations above the MCL at one location that is northeast of 81EW0002. As of 2006 the CS-20 plume was not detected at concentrations above the MCL south of Boxberry Hill Road. The nature and extent of the plume south of Boxberry Hill Road is estimated based on detections below the MCL at three locations around the periphery of the plume.

Groundwater within the CS-20 plume is flowing in a southerly direction with an approximate groundwater velocity of one foot per day in the sandy portions of the aquifer. The CS-20 plume is up to 160 feet thick and the top of the plume is approximately 30 feet below the water table and 70 to 90 feet below the ground surface. The total mass of PCE and TCE (adsorbed and dissolved) in the 2006 CS-20 plume is estimated to be 162 lb based on groundwater data from 2002 to early 2006 (AFCEE 2008a).

2.2.3 FS-29 Plume

The FS-29 plume is also a detached plume. The source of the FS-29 plume has not been identified. All potential source areas upgradient of the FS-29 plume were investigated and remediated, if necessary, through the IRP. The plume is approximately 9,100 feet long and a maximum of 1,400 feet wide (Figure 2-2). The FS-29 plume is defined by concentrations of ethylene dibromide (EDB) higher than the Massachusetts maximum contaminant level (MMCL) of 0.02 µg/L, and by concentrations of carbon tetrachloride (CCl_4) higher than the MCL of 5 µg/L. The plume is defined primarily by EDB and secondarily by CCl_4, which is not as widely distributed as the EDB in the plume. The current (2006) maximum concentrations of EDB and CCl_4 are 0.064 µg/L and 6.4 µg/L, respectively.

Groundwater flow in the FS-29 plume is southwesterly in the trailing edge and becomes more westerly downgradient toward the leading edge. The groundwater velocity is approximately one foot per day in the sandy portions of the aquifer. The FS-29 plume is up to 150 feet thick with the top of the plume approximately 60 feet below the water table and from 120 to 210 feet below the ground surface. The total mass of EDB in the 2006 FS-29 plume is 0.37 lb.

2.2.4 CS-21 Plume

The CS-21 plume is also a detached plume. The source of the CS-21 plume has not been identified. All potential source areas upgradient of the CS-21 plume were investigated and remediated, if necessary, through the IRP. The CS-21 plume is approximately 8,900 feet long and a maximum of 1,500 feet wide, extending from the Hunter Avenue area near the southern MMR boundary, under Route 151, and terminating just west of Falmouth Woods Road (Figure 2-2). The CS-21 plume is defined by TCE concentrations above the MCL, with a current (2006) maximum concentration of 59 µg/L. The highest concentrations are located in the upgradient portion of the plume.

Groundwater flow in the CS-21 plume is southwesterly in the trailing edge and becomes more westerly downgradient toward the leading edge. The groundwater velocity is approximately one foot per day in the sandy portions of the aquifer. The CS-21 plume is up to 210 feet thick with the shallowest portion of the top of the plume approximately 25 feet below the water table and approximately 100 feet below the ground surface. The total mass of TCE in the 2006 CS-21 plume is 276 lb.

2.2.5 FS-13 Plume

The source of the FS-13 plume is a fuel spill that is believed to have occurred in 1972 near the rotary at the east end of Connery Avenue. The plume is defined by groundwater detections of 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene. The maximum 2004 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene concentrations were 383 µg/L and 143 µg/L, respectively (AFCEE 2005b). The FS-13 plume is approximately 650 feet long and 230 feet wide. Long-term monitoring data indicates the plume contaminants are not mobile and have not migrated (AFCEE 2005b).

2.2.6 FS-28 Plume

The FS-28 plume is defined as the extent of groundwater contaminated with EDB at concentrations exceeding the MMCL (0.02 µg/L). The maximum 2007 EDB concentration in the FS-28 plume was 2.54 µg/L (AFCEE 2008b). The plume is approximately 11,800 feet long and a maximum of 1,700 feet wide. The remedial system as described in Section 2.1 minimizes discharge of the plume contaminants to the Coonamessett River and associated bogs.

2.3 OVERVIEW OF THE SELECTED REMEDIES FOR THE CS-4, CS-20, CS-21, FS-13, FS-28 AND FS-29 GROUNDWATER PLUMES

For the purpose of explaining the differences between the remedies that were selected in the RODs and the current cleanup plans, this section describes the remedies that AFCEE committed to in 2000 for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes. The first part of this section provides the descriptions of the remedy for each plume as they appeared in the RODs, and the second part of this section provides additional information regarding the initial design concepts for the remedies as they were envisioned during the remedy selection process.

2.3.1 Selected Remedies as Described in the RODs

As described in the RODs, the selected remedies for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes are as follows:

CS-4 Plume: Discontinue operation of the existing CS-4 plume extraction well fence, which partially captures the plume, and install new extraction wells along the axis of the plume. Extracted water will be treated at the existing CS-4 treatment plant and discharged to the existing CS-4 infiltration gallery. If additional treatment capacity is necessary, water will be sent to the GAC treatment plant and the discharge system that will be constructed to clean up the CS-20 plume.

CS-20 Plume: Construct an axial extraction well system and granular-activated carbon treatment plant for the CS-20 plume. Treated water will be discharged to infiltration galleries.

CS-21 Plume: Construct an axial extraction well system and granular-activated carbon treatment plant for the CS-21 plume. Treated water will be discharged to infiltration galleries.

FS-13 Plume: Long-term groundwater monitoring.

FS-28 Plume: Continued operation of the FS-28 treatment system, including the shallow well-points, and continued operation of the Coonamessett Water Supply Well wellhead treatment system. Also included is continued maintenance of the earthen berms and vinyl sheet piles installed to separate the Coonamessett River from the surrounding bogs.

FS-29 Plume: Conduct additional site characterization and modeling to better understand plume dimensions and hydraulic conditions. Design and construct a groundwater ETR system within the leading portion of the plume to capture EDB and CCl_4 in groundwater. The FS-29 plume will be captured and treated by a GAC system, and the treated water will be discharged to an infiltration gallery. Long-term monitoring will be conducted to demonstrate that the selected remedy is effective and protective of human health and the environment. If, as a result of additional site characterization and modeling, the proposed groundwater ETR system for the FS-29 plume is determined not to be appropriate, the selected remedy will be reviewed. Alternative remedies will then be evaluated to determine which remedy provides the best balance of the nine CERCLA criteria, leading to selection of a new remedy by AFCEE and the EPA, with state concurrence and public input.

For the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes: Monitoring will be conducted to demonstrate that the selected remedies are effective and protective of human health and the environment.

Institutional Land use controls (LUCs) will be put in place to reduce the risk of current and future exposure to contaminated groundwater in the CS-4, CS-20, CS-21, FS-13, FS-28 and FS-29 plumes until cleanup standards are attained in the plumes. The Commonwealth of Massachusetts enforces LUCs on public water supplies and within the Crane Wildlife Management Area.

The Town of Falmouth implements and enforces LUCs on private wells within the town. The Falmouth Board of Health (BOH) approved a series of water well regulations at their 13 September 1999 meeting. These regulations require a permit from the Board of Health for the installation and use of all new wells, including drinking water wells,

irrigation wells, and monitoring wells within the town of Falmouth. Along with other requirements, this regulation states that "A Drinking Water Well must [be] tested for…volatile organic compounds and found to be within potable water limits as defined in 310 Commonwealth of Massachusetts Regulations (CMR) 22.000 Drinking Water Regulations and must not exceed the Commonwealth of Massachusetts' Maximum Contaminant Levels." AFCEE will coordinate with the Falmouth Board of Health periodically (but not less than annually) to ensure the Town knows of any changes to the plume configurations and/or contaminant concentrations.

The Air Force is responsible for ensuring that the preceding two 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 ESD.

CERCLA reviews will be conducted every five years to ensure that the remedies continue to provide adequate protection of human health and the environment.

The selected remedies are one aspect of the overall cleanup strategy for the MMR. The following three-step process has been agreed to solely for groundwater cleanup at the MMR due to unique circumstances presented by the location of the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes within the sole-source aquifer on upper Cape Cod. For the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes, the following steps will be taken:

1. Remediate the aquifer to federal and state drinking water standards or other risk-based cleanup levels.
2. When MCLs, MMCLs, or other risk-based cleanup levels are achieved and before the system is shut off, perform a risk assessment to determine if unacceptable ecological and/or human health risks are present; continue system operation, and/or pursue additional measures as required to achieve acceptable risks.
3. Once acceptable risks have been achieved, evaluate the technical and economic feasibility of additional remediation to approach or achieve background concentrations.

2.3.2 Initial Conceptual Designs for the CS-4, CS-20, CS-21, and FS-29 Plumes

In 1999, when the feasibility studies were done for the SWOU plumes (AFCEE 2000d, 1999b), preliminary ETR system designs were developed (1) to use as the basis for numerical groundwater modeling simulations that were developed to estimate approximate pumping rates and cleanup times, (2) to form the basis of cost estimates, and (3) to provide the public stakeholders with a conceptual image of the system layout so they could evaluate potential construction impacts and other aspects of the remedial alternatives. The selected remedy for the FS-28 plume was not conceptual and utilized an existing remedial system; therefore, the FS-28 remedy will not be addressed in this section. Active treatment was not selected for the FS-13 plume and the plume will not be addressed in this section.

For the CS-4 plume, the conceptual design called for replacing the existing extraction well fence with a new extraction system that used approximately three extraction wells located along the longitudinal axis of the plume (Figure 2-3). Groundwater modeling conducted during the feasibility study indicated that approximately 300 gpm would be needed to capture the plume. It was envisioned that 200 gpm would be processed at the existing treatment facility and that the balance (approximately 100 gpm) would be processed at a new treatment facility to be built for the adjacent CS-20 plume.

The conceptual design for the CS-20 plume included the construction of an ETR system capable of treating 500 gpm for hydraulic capture and treatment of plume contaminants. The water would be treated at a new treatment facility to be built for the CS-20 plume. Because the goal of the ETR system was plume capture, the extraction system conceptual design consisted of an extraction well located at the most downgradient (southern) extent of the plume (Figure 2-3).

The conceptual design for the CS-21 plume included the construction of an ETR system capable of treating 1,200 gpm in the upgradient portion of the plume and a separate leading edge extraction and reinjection well pair and treatment system processing 200 gpm. The system would be designed for hydraulic capture and treatment of plume

contaminants. Because the goal of the ETR system was plume capture, the extraction system conceptual design included an extraction well located at the most downgradient (southern) extent of the plume (Figure 2-3).

The conceptual design for the FS-29 plume included the construction of an ETR system capable of treating 600 gpm for hydraulic capture and treatment of plume contaminants. Modeling indicated that a small portion of the upgradient (northeastern) part of the FS-29 plume would be captured by the ETR system that was planned for the adjacent CS-21 plume. Because the goal of the ETR system was plume capture, the extraction system conceptual design consisted of two extraction wells located in the downgradient (western) portion of the plume (Figure 2-4).

3.0 DESCRIPTION OF SIGNIFICANT DIFFERENCES AND THE BASIS FOR THESE DIFFERENCES

This section describes the differences between the selected remedies (as described in the RODs) for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes and the design modifications documented in this ESD. The following subsections describe the current design and the rationale for deviating from the selected remedies as they were described in the RODs.

3.1 SIGNIFICANT DIFFERENCES FROM THE SELECTED REMEDIES

There were no significant differences between the selected remedy and design of the CS-21 and FS-28 remedial systems or the selected remedy for the FS-13 plume (long-term monitoring); therefore the CS-21, FS-28, and FS-13 remedies will not be addressed in this section. During the feasibility studies for the CS-4, CS-20, and FS-29 plumes, the relative effectiveness, estimated costs, and expected outcomes for various remedial alternatives were compared with each other (AFCEE 2000d, 1999b). Because the physical and chemical data available at the completion of the SWOU RI were relatively limited, the evaluations of remedial alternatives were based on very preliminary design concepts. The amount of physical and chemical data that supported the wellfield design in 2003 was approximately twice the amount that was available for the feasibility studies in 1999. As the understanding of the site conditions became more refined through the collection of additional data, the designs for the groundwater ETR systems evolved from conceptual designs to detailed engineering and construction plans.

Although there are several changes between the conceptual designs for the remedies AFCEE committed to in the RODs and the current designs, most of these changes are not considered by EPA to be "significant" post-ROD changes that would require the preparation of an ESD document. For the CS-4, CS-20, and FS-29 plumes, what is significant about the differences between the current design and the remedies described in the RODs is the concept of how much of the plumes would be captured by the ETR systems. In 1999 and 2000, the conceptual remedy for each plume was an active total capture remedial system. The current designs for the ETR systems for the CS-4, CS-20,

and FS-29 plumes do not capture the most downgradient parts of these plumes. Instead the downgradient portion of these plumes will reach cleanup levels through natural attenuation. This significant change and a few other minor changes to the conceptual designs presented in the RODs are described in this section.

3.1.1 Description of the Current Design

The ETR system that was built treats and discharges water extracted from the CS-4, CS-20, and FS-29 plumes[1]. The final wellfield design for the plumes is presented on Figure 3-1 and Figure 3-2. As illustrated in Figure 3-1 and Figure 3-2, contaminated groundwater from within the CS-4, CS-20, and FS-29 plumes is extracted as follows:

- CS-4 plume: Three extraction wells are used to remove groundwater from the CS-4 plume. A pair of wells oriented cross gradient from each other are located between the former 13-well extraction fence (now abandoned) and Route 151. A third well is located closer to (yet upgradient of) the leading edge of the plume between Route 151 and Boxberry Hill Road. The total flow rate from the three CS-4 extraction wells is 620 gpm.
- CS-20 plume: Two extraction wells will be used to remove groundwater from the CS-20 plume. The pair of wells is axially oriented; one north of Route 151 and one located on Boxberry Hill Road. The total flow rate from the two CS-20 extraction wells is 775 gpm.
- FS-29 plume: Two extraction wells will be used to remove groundwater from the FS-29 plume. The pair of wells will be oriented crossgradient from each other and located slightly west of Falmouth Woods Road, about 2,000 feet upgradient of the leading edge of the plume. The total flow rate from the two FS-29 extraction wells is 525 gpm.

All groundwater extracted from the three plumes (at a combined rate of 3,320 gpm when also including CS-21) is processed at a new treatment plant located on the MMR. The treatment process separates the influent flow into six separate process flows, each with its own train of two sequential GAC vessels to adsorb organic contaminants dissolved in the water (primarily PCE and TCE). As the carbon in each vessel adsorbs contaminants and

[1] The Hunter Avenue Treatment Facility also contains a GAC treatment system to process water extracted from the LF-1 and CS-23 plumes; however, those components are not considered part of the treatment system for the CS-4, CS-20, CS-21, and FS-29 plumes.

loses its effectiveness, it will be removed, shipped off-site for regeneration, and returned for reuse.

Electric pumps located in each extraction well will generate enough pressure to push the contaminated water to the surface and on through several thousand feet of underground piping to the treatment plant. A pair of booster pumps will force the water through the GAC system and out through another several thousand feet of underground piping to the reinjection wells and infiltration systems where treated water is returned to the aquifer (Figure 3-1 and Figure 3-2). Treated water will be returned to the aquifer in a strategic manner designed primarily to (1) help push contaminated groundwater toward extraction wells, (2) mitigate adverse water-level drawdown or mounding near sensitive ecosystems, and (3) maintain regional groundwater flow patterns.

3.1.2 Differences between the Conceptual Design and Current Design

The selected remedies for the CS-4, CS-20, and FS-29 plumes as they were described in the ROD documents signed in the year 2000, were summarized in Section 2.3. Through additional site characterization and the design process, the plans for extracting, treating, and reinjecting/infiltrating groundwater from these three plumes have evolved from very general concepts to a detailed wellfield design. The following discussion highlights some of the differences between the early conceptual designs presented in the RODs and the current designs. The justifications for each deviation are provided in Section 3.2.

3.1.2.1 Significant Difference

As mentioned previously, the significant difference with the designs for the CS-4, CS-20, and FS-29 plumes is that a certain portion of each plume will not be captured by the ETR system. Conceptually, the remedies selected in the RODs for the CS-4, CS-20, and FS-29 plumes were intended to capture the entire mass of each plume. The wellfield design process began with the intent of developing ETR systems for total capture in each plume. However, through analyzing various designs for system performance, effectiveness, property access issues, and other constraints, final designs for the CS-4,

CS-20, and FS-29 plumes were developed that meet remedial action objectives while allowing for a relatively small portion of each plume to remain uncaptured and attenuate naturally. AFCEE will monitor the concentrations of the plume contaminants in the uncaptured portion of the plumes to confirm that they do not present unacceptable human health risks and that the fate and transport of the uncaptured portion of the plume is similar to predictions. Monitoring results that are not similar to predictions will be evaluated and additional groundwater sampling, drilling, or groundwater modeling may be conducted.

The extent of the capture zones and the extent of the plumes are approximated using a combination of observed data and inferred conditions. The amount of each plume that is not captured is an approximation for each remedial system. Plume definitions were developed conservatively using both recent and historical chemical groundwater data. Chemical groundwater data is combined with knowledge of groundwater flow velocities, plume trajectories, and groundwater modeling to estimate plume nature and extent. The extent of the capture zones is largely estimated through model predictions of the extent of hydraulic stress and impacts on groundwater flow due to operation of the remedial system. For CS-4 and CS-20, the extent of the plumes is predicted to extend outside the downgradient limits of the capture zones. The conceptual model suggests that a portion of the CS-4 and CS-20 plumes are beyond the downgradient extent of the capture zones at concentrations in excess of MCLs, MMCLs, or GW-1 standards for respective contaminants of concern (COCs).

Groundwater modeling of the CS-4 plume conducted during wellfield design, using the 2002 plume shell, indicated that the total PCE plume shell mass was approximately 70.4 lb at the time of system startup, with approximately 3.1 lb of PCE predicted to be downgradient of the capture zone (downgradient of 02EW0016). This uncaptured part of the plume was predicted to migrate south and attenuate to below cleanup levels by year 2008 and before reaching the northern shore of Coonamessett Pond. More recently the total PCE mass in the CS-4 plume shell was re-estimated using the 2006 PCE plume shell. The revised estimate for total PCE mass in the CS-4 plume is approximately

39.2 lb, with approximately 0.63 lb downgradient of the capture zone, which was predicted to have naturally attenuated below the MCL by approximately June 2007 (AFCEE 2008a). AFCEE will monitor the concentrations of CS-4 plume contaminants in the uncaptured portion of the plume to confirm that they do not present unacceptable human health risks and that the uncaptured portion of the plume behaves as predicted.

For the CS-20 system, groundwater modeling conducted after the wellfield design was developed indicated that the total 2006 CS-20 plume mass (dissolved and adsorbed) is 162 lbs with approximately 8.7 lbs predicted to be downgradient of the capture zone at the time of system startup (Figure 3-3) (AFCEE 2008a). This uncaptured part of the plume is predicted to migrate south, with the PCE concentrations in this uncaptured part of the plume predicted to reach cleanup levels by year 2024. In the original CS-20 wellfield design that incorporated a leading edge extraction well, the portion of the plume between the middle extraction well and the leading edge extraction well was predicted to reach cleanup levels by year 2013 (AFCEE 2004a). AFCEE will monitor the concentrations of CS-20 plume contaminants in the uncaptured portion of the plume to confirm that they do not present unacceptable human health risks and that the uncaptured portion of the plume behaves as predicted.

The wellfield design for the FS-29 plumes utilizes two extraction wells located close to Falmouth Woods Road. FS-29 plume contamination located downgradient (west) of these extraction wells will not be captured by the current design. The entire 2002 FS-29 plume shell was predicted to contain 0.46 lb of EDB and CCl_4 (scaled to the EDB MMCL) by the time the system was predicted to start in year 2005.5. The uncaptured portion of the 2002 plume shell was approximated to contain 0.0029 lb of EDB and CCl_4 (scaled to the EDB MMCL) at year 2005.5. Monitoring of the FS-29 plume will be conducted downgradient of the extraction wells to ensure that it does not present unacceptable human health risks and to demonstrate that the aquifer is restored within a reasonable time frame. The modeling conducted during wellfield design predicted that the concentrations of EDB, within the part of the FS-29 plume located downgradient (west) of the extraction wells, would reach cleanup levels by approximately year 2012. The total mass in the 2006 FS-29 plume shell is approximately 0.37 lb with

approximately 0.035 lb downgradient of the capture zone, which is predicted to naturally attenuate below the MCL by approximately year 2011.75 (AFCEE 2008a).

3.1.2.2 Other Minor Differences

There are two minor differences between the selected remedies in the RODs and the current cleanup strategy for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes. The minor differences are related to the three-step process (for the five plumes with active treatment) and the LUCs (applicable to all six of the plumes).

As previously mentioned, the RODs included specific language describing a three-step process for how remedial action objectives would be achieved for the plumes. An overview of this process is provided in Section 2.3.1 of this document, and the full length versions are presented in Section 2.8.4 of the *Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes* (AFCEE 2000a) and Section 2.8.5 of the *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes* (AFCEE 2000b). AFCEE, EPA, and the MassDEP collectively developed the process that was outlined in the SWOU RODs in 1999. Very briefly stated, the process called for first remediating the aquifer to state and federal drinking water standards, next conducting a risk assessment to determine if unacceptable risks were posed by residual contamination and to determine how remediation should continue, and lastly (after acceptable risks have been achieved) evaluating the technical and economic feasibility of restoring the aquifer to background conditions. As the Installation Restoration Program at MMR matured and more was learned about how the plumes change with time in response to restoration activities, it became apparent to AFCEE and the regulatory agencies that revisions to the three-step process were necessary to accurately reflect the strategy for achieving remedial action objectives. In 2002, AFCEE and the regulatory agencies revised the three-step process. The revised process continues to require AFCEE to conduct a residual risk assessment before treatment system shut down and to evaluate the technical and economic feasibility of achieving background concentrations in the aquifer after acceptable risk levels have been achieved. The substantial change made to the three-step process in 2002 was that AFCEE is no longer required to demonstrate that contaminants have been detected at

cleanup levels (MCLs and MMCLs) in the aquifer before proceeding with the second and third steps in the process.

The 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 ESD.
2. **In accordance with applicable EPA guidance, perform a residual risk assessment(s) to determine if unacceptable ecological and/or human health risks are present; continue system operation and/or pursue additional measures as required to achieve acceptable risks.** AFCEE shall conduct a residual risk assessment(s), if deemed necessary, to determine whether the COCs remaining in the aquifer continue to pose unacceptable ecological and/or human health risks. This risk determination shall be made jointly by AFCEE and the EPA, in consultation with the MassDEP, and may result in aquifer cleanup that is more protective than the National Contingency Plan (NCP) point-of-departure risk of 10^{-6} [40 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, evaluate the technical and economic feasibility of additional remediation to approach or achieve background concentrations.** 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 the EPA, with input from the 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 ESD, AFCEE will execute an ESD (with public comment) or ROD Amendment, as appropriate. Whether any such additional cleanup actions result in a significant or fundamental change to this final ESD shall be determined by AFCEE in consultation with the 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 1999). In this manner, such changes will be subject to regulatory review and stakeholder involvement through issuance of a new ESD and/or ROD amendment. 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.

A second minor difference involves changes to the LUCs. As the Installation Restoration Program at MMR matured it became apparent to AFCEE and the regulatory agencies that revisions to the LUCs were necessary to protect area residents from exposure to contaminants in groundwater and surface water. Groundwater from the Southwest plumes 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). Portions of the Southwest plumes have migrated past the MMR boundary into the neighboring town of Falmouth. Therefore, administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting

land or resource use (i.e., LUCs) have been established for this area of concern to avoid the risk of exposure to groundwater from the plumes. These LUCs are needed both on-base and off-base, within the town of Falmouth, until the groundwater from the Southwest plumes no longer poses an unacceptable risk. Contaminants from the FS-28 plume have not been detected above action levels in the Coonamessett River and groundwater data indicates any future surface water detections will remain below action levels; therefore, LUCs are not necessary to avoid risk of exposure to surface water or fish from the Coonamessett River.

The performance objectives of the LUCs are:

- Prevent access to, or use of, the groundwater from the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 plumes until the groundwater no longer poses an unacceptable risk; and

Maintain the integrity of the current or future remedial or monitoring system such as treatment systems and monitoring wells.

The LUCs will encompass the area including the Southwest plumes (Figure 3-4) and surrounding areas to reduce potential exposure to the plume. The on-base area of concern is controlled and operated by the Army and the Air Force, who lease this land from the Commonwealth of Massachusetts. It is expected that these entities (Army and Air Force) will control the area of concern and the surrounding area for the duration of this ESD. 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 a level 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 two 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 ESD. The Commonwealth of Massachusetts only has enforcement authority regarding the second LUC. In the event that the Town of Falmouth fails to promptly enforce the first LUC or the Commonwealth of Massachusetts fails to promptly enforce the second LUC, the Air Force will act in accordance with the third from the 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 new 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 A, cover documented and anticipated areas of contamination from the Southwest plumes. 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 Southwest plumes within the town of Falmouth. While Figure 3-4 shows the current area of LUCs in the town, the Falmouth BOH may modify the areas where well use is excluded, and this LUC will apply to such areas even if they differ from the area shown in Figure 3-4.
2. In addition to the 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 Southwest plumes 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 Southwest plumes.

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 BOH Well 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 the remedy.

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 Guards 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 review 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 Southwest plumes 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 Southwest plumes are 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 and the MassDEP, in order to curtail the digging activity. If the Dig Safe notification indicates proposed work near monitoring wells or 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 Southwest

plumes. 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 such 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 Southwest plumes; 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 ESD, 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 Southwest plumes.
b. Demonstrate and document that the private well is not capable of drawing contaminated groundwater originating from the Southwest plumes, 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 the well may pose to human health. The Air Force shall submit a draft version of any such risk assessment to EPA for review and concurrence.
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 Southwest plumes having carcinogens in excess of applicable or relevant and appropriate requirements (ARARs) (i.e., MCLs, non-zero maximum contaminant level goals), and prevent exposure to groundwater from the Southwest plumes 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 hazard index 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 (i) whether the use restrictions and controls referenced above were effectively communicated, (ii) whether the operator, owner and state and local agencies were notified of the use restrictions and controls affecting the property, and (iii) 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 LUC objectives or the final remedy. If the Air Force discovers a proposed or ongoing activity that would be or is inconsistent with the LUC 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 LUC 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 ESD, the Air Force will provide notice to the EPA and MassDEP at least six months prior to relinquishing the lease to the Southwest plumes 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, implement actions, or modify land use without approval by the EPA and MassDEP. The Air Force, in coordination with other agencies using or controlling the Southwest plumes 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 the Southwest plumes.

3.2 BASIS FOR DIFFERENCES FROM THE SELECTED REMEDIES

During the wellfield design process, AFCEE tested the performance of designs that included extraction wells located downgradient of the leading edges of the CS-4, CS-20, and FS-29 plumes. There were no significant differences between the selected remedy and design of the CS-21 and FS-28 remedial systems or the selected remedy for the FS-13 plume (long-term monitoring); therefore the CS-21 and FS-28 remedial systems will not be addressed in this section.

AFCEE attempted to design a system that would capture the entire CS-4 plume, and modeled several designs that included an extraction well placed where the most downgradient part of the plume was expected to be in mid-2005. Optimal placement of an extraction well was constrained due to the topography and the small, developed private properties in the area, one of which is a historical home. Modeling indicated that if an extraction well were installed at the most downgradient extent of the plume, a relatively high flow rate would be needed to create the large capture zone that would be necessary to capture the plume. The large capture zone would be necessary because the well could not be optimally located due to physical constraints, and to compensate for some uncertainty in the local groundwater flow direction near the leading edge of the plume. The high-rate extraction well would not be very efficient because it would capture a large amount of clean water and only a small amount of contaminated water.

This inefficiency is due to the low concentrations of PCE and TCE downgradient of Route 151. Ecological impacts, such as the drawdown of water levels in the wetlands located between Boxberry Hill Road and the northern shore of Coonamessett Pond, were also a concern.

In simulations that included the most southern CS-4 extraction well in a location entirely downgradient from the leading edge of the CS-4 plume (on or close to Boxberry Hill Road), the next closest CS-4 extraction well (or well pair, in some cases) was located just north of Route 151. In the best performing designs, the most southern extraction well was placed on land owned by the Town of Falmouth between Boxberry Hill Road and Route 151. Fate and transport modeling of the CS-4 plume under scenarios that placed the most southern CS-4 extraction well between Route 151 and Boxberry Hill Road indicated that the concentrations of CS-4 contaminants in the uncaptured leading edge of the plume would reach cleanup levels by year 2008. Groundwater modeling conducted during wellfield design, with the 2002 CS-4 plume shell, indicated that the total PCE plume shell mass was approximately 70.4 lbs with approximately 3.1 lbs of PCE predicted to be downgradient of the capture zone before system startup (downgradient of 02EW0016). This uncaptured part of the plume is predicted to migrate south, but the concentrations of plume contaminants (primarily PCE and TCE) in this uncaptured part of the plume are predicted to reach cleanup levels by year 2008, prior to this water reaching the northern shore of Coonamessett Pond. The wellfield design modeling predicted the plume cleanup by approximately 2016. More recent groundwater sampling, and modeling conducted in 2007, approximated the total PCE mass in the 2006 CS-4 plume shell at 39.2 lb with approximately 0.63 lb downgradient of the capture zone. The uncaptured portion of the plume is predicted to naturally attenuate below the MCL by approximately 2007.58 and most of the upgradient plume is estimated to cleanup by approximately 2014 (AFCEE 2008a). There is some contamination retained in low-hydraulic conductivity units, upgradient of the extraction wells, which is predicted to naturally attenuate without migrating downgradient.

The wellfield design for the CS-20 plume presented in the *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Wellfield Design Report* (AFCEE 2004a) consisted of three axially located wells (Figure 3-5). The most downgradient well was located downgradient of the 2002 CS-20 plume based on model-predicted location of the plume in 2005.5 (system start date assumed for the wellfield design modeling). After the wellfield design report AFCEE contacted property owners in the vicinity of the leading edge extraction well (along Rasberry Path and Goeletta Drive) but was unable to acquire access from private property owners in the area necessary for the leading edge extraction well. AFCEE approached the Town of Falmouth to gain access for placement of the leading edge well in the town-owned road Goeletta Drive but the Town was reluctant to grant access. At the same time AFCEE continued to gather plume contaminant information (2005 and 2006) to refine the understanding of the leading edge contaminant distribution; specifically, drilling and sampling using sonic and direct push technology was conducted along Boxberry Hill Road, Brigantine Drive, and Goeletta Drive. The results indicate that the CS-20 plume does not extend south to Goeletta Drive. The drilling results were used with monitoring well sampling data to construct the CS-20 2006 plume shell. The 2006 CS-20 plume only extends approximately 800 feet south of Boxberry Hill Road (Figure 3-3) compared to the wellfield design modeling, which predicted that in 2006 the CS-20 plume would extend approximately 2,300 feet south of Boxberry Hill Road to Rasberry Path. Based on the 2006 CS-20 plume shell, it was estimated that the total 2006 CS-20 plume mass (dissolved and adsorbed) is 162 lb with approximately 8.7 lb predicted to be downgradient of the capture zone at the time of system startup (Figure 3-3) (AFCEE 2008a). Model predictions of the operation of the CS-20 remedial system indicate a small portion of the plume with PCE concentrations above 50 µg/L is outside the capture zone (Figure 3-3). The uncaptured portion of the plume quickly decreases in concentration through natural attenuation. The maximum distance the uncaptured portion of the CS-20 plume, as defined by above-MCL concentrations, is predicted to migrate downgradient is approximately 1,300 feet. Most of the plume is predicted to reach cleanup levels by approximately 2016 with some contamination retained in low-

hydraulic-conductivity units that slowly decrease in concentration over a longer timeframe.

The results of the attempts for property access and the modeling with the 2006 plume shell were discussed with the EPA and MassDEP. Periodic updates were made to the Senior Management Board regarding property access issues for the downgradient extraction well (Appendix B). Based on property access issues and the 2006 modeling results, and without objection from EPA or MassDEP, AFCEE decided not to continue pursuing property access for a downgradient extraction well and instead proceeded with the CS-20 portion of this ESD.

Groundwater modeling conducted during the wellfield design effort for the FS-29 plume showed that a leading-edge extraction well was not effective because very little mass was predicted to be downgradient of Falmouth Woods Road at the time of system startup. Currently the leading edge of the FS-29 plume is relatively thin (10 to 20 feet thick) and consists of low concentrations of EDB (below 0.06 µg/L). Even at system startup, the concentrations of EDB pumped out of a leading edge extraction well were predicted to be below the MMCL. Simulations excluding the leading edge well showed the uncaptured EDB contamination was dilute and would attenuate to concentrations below the MMCL by year 2012 and would not migrate west of Route 28A. Since the homes and businesses located near the leading edge of the FS-29 plume are connected to the Falmouth municipal water supply and do not have private wells that could intercept the plume, active remediation of the downgradient part of the plume would not effectively reduce potential health risks.

From a constructability standpoint, it is not feasible to design a system that would convey water from an extraction well located at the leading edge of the FS-29 plume to a centrally located treatment facility. This is primarily because the land between Falmouth Woods Road and the leading edge of the plume is a highly developed residential area covered almost entirely by houses, landscaped lawns and gardens, steep boulder-covered slopes, and roads under which a variety of utilities are buried. Theoretically, a pipeline could be constructed that followed Route 28 north to the intersection with Route 151 and

then followed Route 151 east to a point where it could connect to the influent and effluent piping networks; however, this would be a long circuitous and hazardous route. Construction of a stand-alone ETR system at the leading edge of the FS-29 plume is also constrained by severe topography and limited accessibility. The land use and topography in this area provide very few options for monitoring wells, which require a relatively flat area of approximately 80 feet by 20 feet to accommodate the drilling equipment during well installation. Extraction wells require even larger working areas to install, and suitable constructible locations for extraction wells, pipelines, or even a relatively small stand-alone treatment system are not available in the area where they would be needed to effectively capture the leading edge of the FS-29 plume.

The rationale for the clarification of and changes in the three-step process for achieving remedial action objectives is that the SWOU RODs were too prescriptive. The revised three-step process for achieving remedial action objectives includes the same commitment to conduct a residual risk assessment and to evaluate the feasibility of achieving background conditions, but it is more flexible regarding when in the cleanup process these steps are taken. Of course, pursuant to the NCP, any significant or fundamental changes would be documented by an Explanation of Significant Differences or ROD amendments.

4.0 STATUTORY DETERMINATION

This ESD modifies the remedies for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 groundwater plumes. These remedies are protective of human health and the environment, comply with federal and Commonwealth of Massachusetts requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost-effective. The remedies for the CS-4, CS-20, CS-21, FS-13, FS-28, and FS-29 groundwater plumes utilize permanent solutions to the maximum extent practicable, and satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, in accordance with Section 121 of CERCLA. While the changes and clarifications contained in the ESD are significant, none of the proposed changes fundamentally changes the remedy.

(intentionally blank)

5.0 STATE AGENCY COMMENTS AND PUBLIC PARTICIPATION ACTIVITIES

The regulatory agencies (EPA and MassDEP) were periodically updated on progress during the wellfield design development process. Presentations on the wellfield design development were made to the Plume Cleanup Team (PCT) in May and June 2003. The PCT approved of the wellfield designs for the CS-21 and FS-29 plumes in June 2003. The regulatory agencies reviewed the *Draft Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Wellfield Design Report* (AFCEE 2004b), and the resolution to regulatory agency comments on the wellfield design are reflected in the *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Wellfield Design Report* (AFCEE 2004a).

EPA and MassDEP were updated on attempts at obtaining property access for a downgradient extraction well in the CS-20 plume. Periodic updates were made to the PCT throughout 2005 and 2006 regarding property access issues related to the CS-20 plume.

5.1 COMMENTS FROM THE MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

MassDEP concurrence with this ESD can be found in Appendix C.

5.2 PUBLIC PARTICIPATION ACTIVITIES

A public comment period was not required for this ESD. Periodic updates were made to the Plume Cleanup Team (PCT) and Senior Management Board regarding the major difference documented in the ESD during 2005 and 2006. A summary presentation regarding the ESD was given to the PCT on 9 April 2008.

In accordance with Section 117(d) of CERCLA, 42 United States Code §9617(D), AFCEE will publish a notice in the Cape Cod Times and the Falmouth Enterprise that describes this ESD and its availability in the Administrative Record. In accordance with 40 CFR Section 300.435(c) (2) (i), this ESD and all documents that support the changes and clarifications are contained in the Administrative Record for the Installation Restoration Program at MMR.

(intentionally blank)

6.0 REFERENCES

AFCEE (Air Force Center for Engineering and the Environment). 2008a (May). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Baseline System Performance and Ecological Impact Monitoring Report*. A4P-J23-35BC24VC-M22-0003. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2008b (March). *Fuel Spill-28 2007 Summary Letter Report*. 337105-SPEIM-FS28-SLR-002. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

———. 2005a (September). *Chemical Spill-4 (CS-4) Removal Action Report*. Prepared by AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2005b (January). *Fuel Spill-13 Long-Term Monitoring Data Transmittal – November 2004 Results*. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

———. 2004a (August). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Wellfield Design Report* A3P-J23-35Z00102-M23-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2004b (March). *Draft Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, and Fuel Spill-29 Wellfield Design Report* A3P-J23-35Z00102-M23-0001. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA

———. 2003 (July). *Final Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-29 Pre-Design Investigation Report.* A3P-J23-35Z00102-M17-0007. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2000a (October). *Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes.* AFC-J23-35Q86101-M26-0009. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2000b (February). *Final Record of Decision for the CS-4, CS-20, CS-21, and FS-13 Plumes.* AFC-J23-35Q86101-M26-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2000c (February). *Final Proposed Plan for the Fuel Spill-28 and Fuel Spill-29 Plumes in the Southwest Operable Unit.* AFC-J23-35Q86101-M25-0008. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 2000d (January). *Final FS-28 and FS-29 Groundwater Feasibility Study*. AFC-J23-35Q86101-M16-0011. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

———. 1999a (November). *Final FS-28 Non-Time-Critical Removal Action Memorandum*. AFC-J23-35S19002-M17-0014. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———.1999b (June). *Final Southwest Operable Unit Feasibility Study*. AFC-J23-35Q86101-M16-0006. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

———. 1999c (June). (Final) *Proposed Plan for the Southwest Operable Unit (CS-4, CS-20, CS-21 and FS-13 plumes only)*. AFC-J23-35Q86101-M25-0004. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

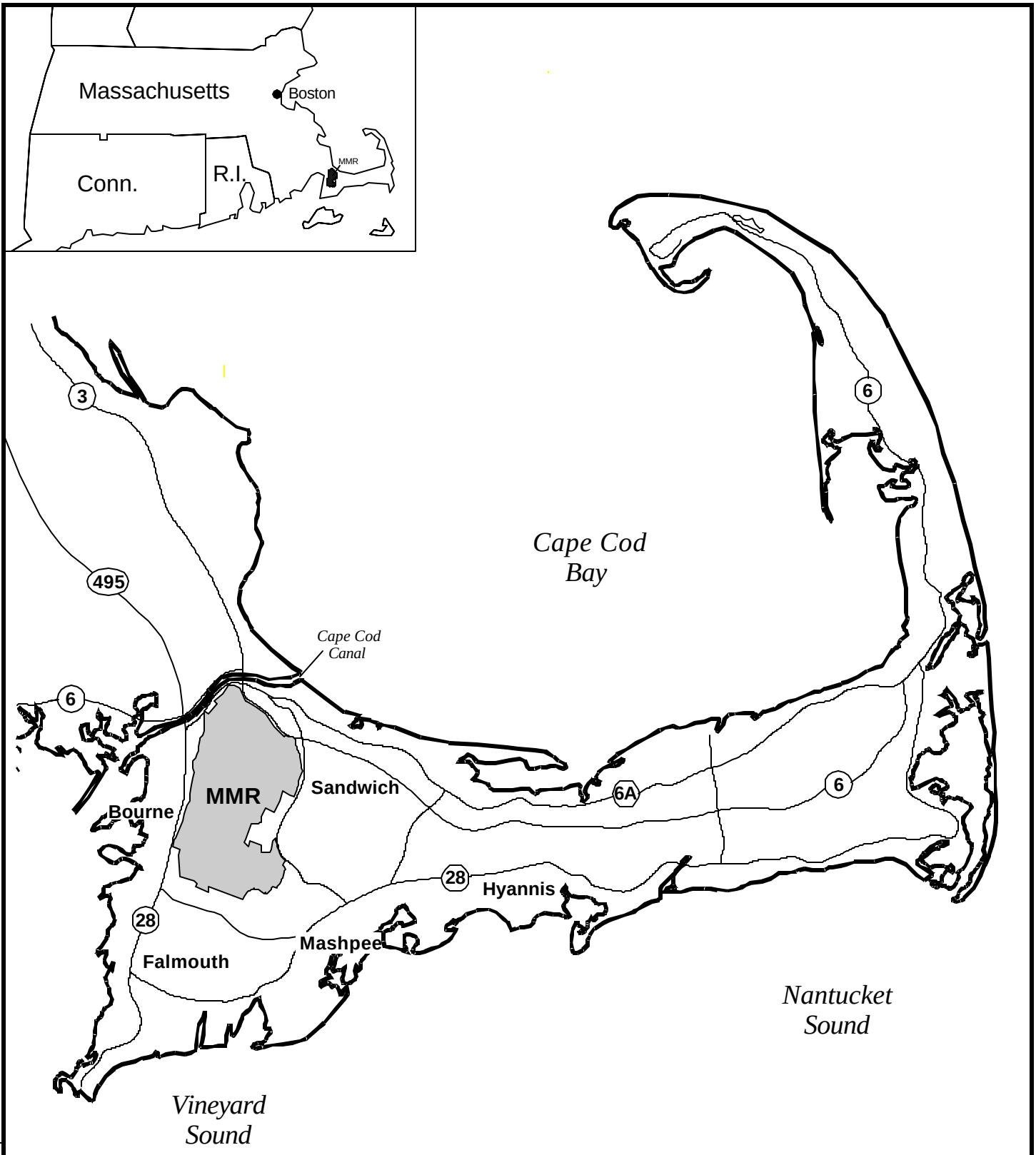
———. 1998 (March). *FS-28 Treatment System Extraction Well-1 (EW-1) Evaluation Report Time Critical Response Action.* AFC-J23-35Q86101-M17-0001. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

United States Environmental Protection Agency Region I and the United States Department of Defense, National Guard Bureau. 1991 and subsequently amended. Federal Facility Agreement Under CERCLA § 120 and RCRA § 7003 In the matter of: The U.S. Department of Defense, National Guard Bureau, Massachusetts Military Reservation, Cape Cod, MA.

EPA (United States Environmental Protection Agency). 1999. *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents.* OSWER 9200.1-23P.

Stone & Webster. 1997 (August). *FS-13 Remedial Investigation/Feasibility Study Data Package.* Prepared for Installation Restoration Program, Air National Guard Readiness Center, Andrews Air Force Base Maryland, by Stone & Webster Environmental Technology & Services, Boston, MA.

FIGURES



JACOBS

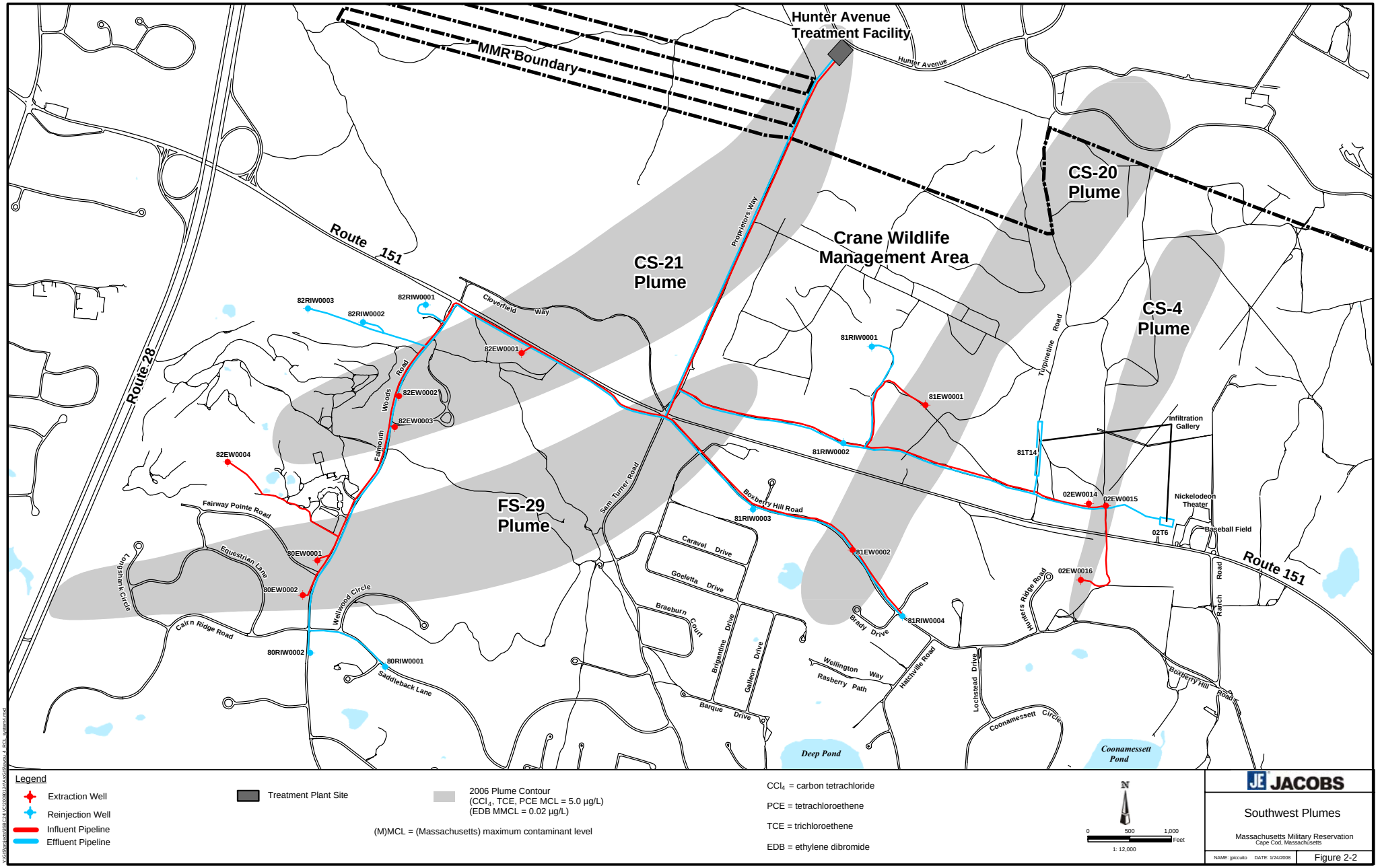
Massachusetts Military Reservation
Cape Cod, Massachusetts

Massachusetts Military Reservation
Cape Cod, Massachusetts

12/7/04 jpFile:CAPEFIG.cdr

Figure 2-1

Y:\projects\3580C24\WC\2004\1207\Graphics\CAPEFIG.cdr



Legend

- Extraction Well
- Reinjection Well
- Influent Pipeline
- Effluent Pipeline
- Treatment Plant Site
- 2006 Plume Contour (CCl_4, TCE, PCE MCL = 5.0 µg/L) (EDB MMCL = 0.02 µg/L)

(M)MCL = (Massachusetts) maximum contaminant level

CCl_4 = carbon tetrachloride

PCE = tetrachloroethene

TCE = trichloroethene

EDB = ethylene dibromide

N

0 500 1,000 Feet

1: 12,000

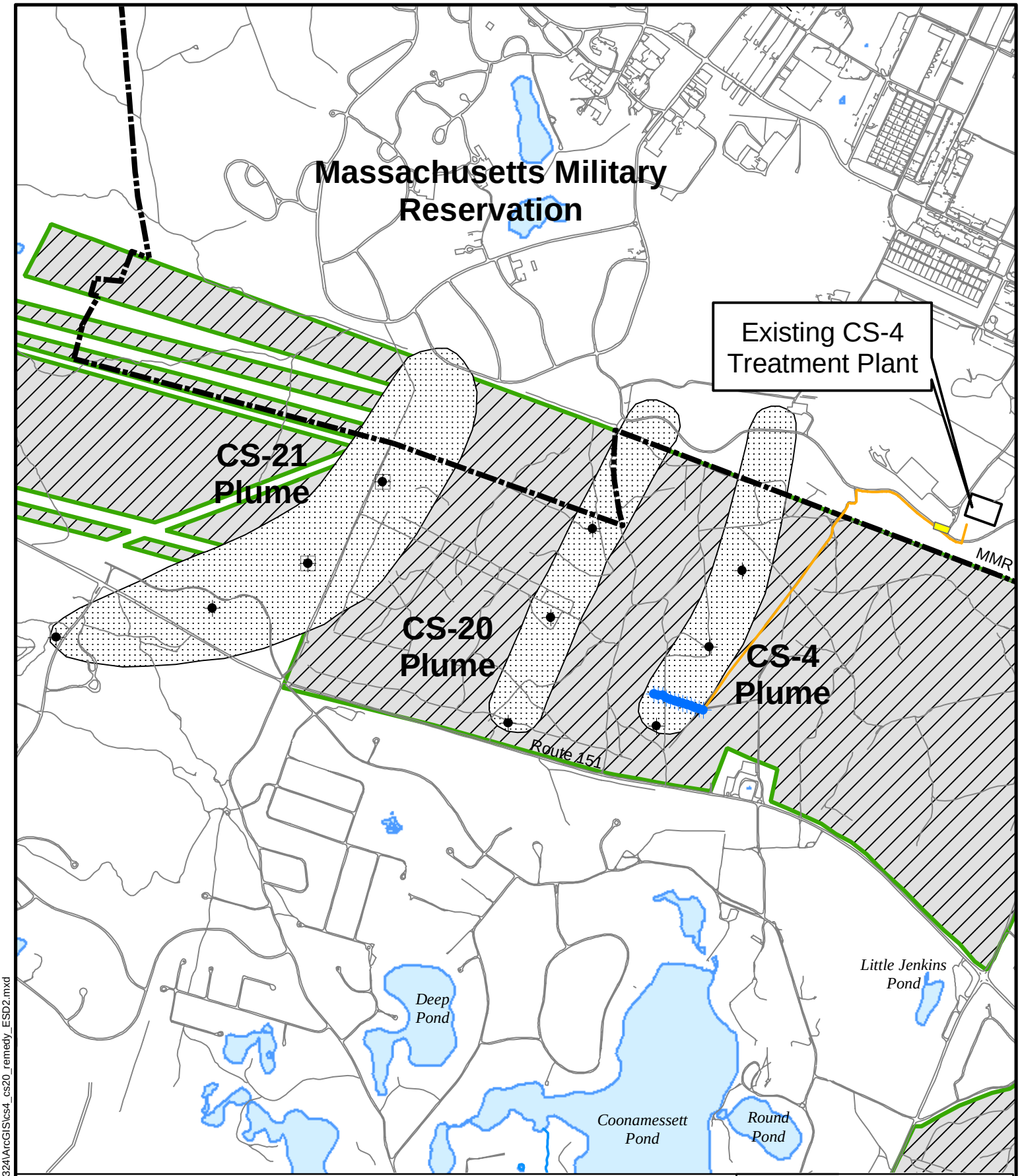
JE JACOBS

Southwest Plumes

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuto DATE: 1/24/2008

Figure 2-2



Legend

- Future Extraction Wells
- Future Paired Deep and Shallow Extraction Wells
- Old CS-4 Extraction Wells
- Old CS-4 Pipeline
- MMR Boundary
- Old CS-4 Infiltration Gallery
- Plume Boundary - 1998 (based on applicable MCL exceedance)
- Crane Wildlife Management Area

N

0 875 1,750 Feet

Scale 1:21,000

JACOBS

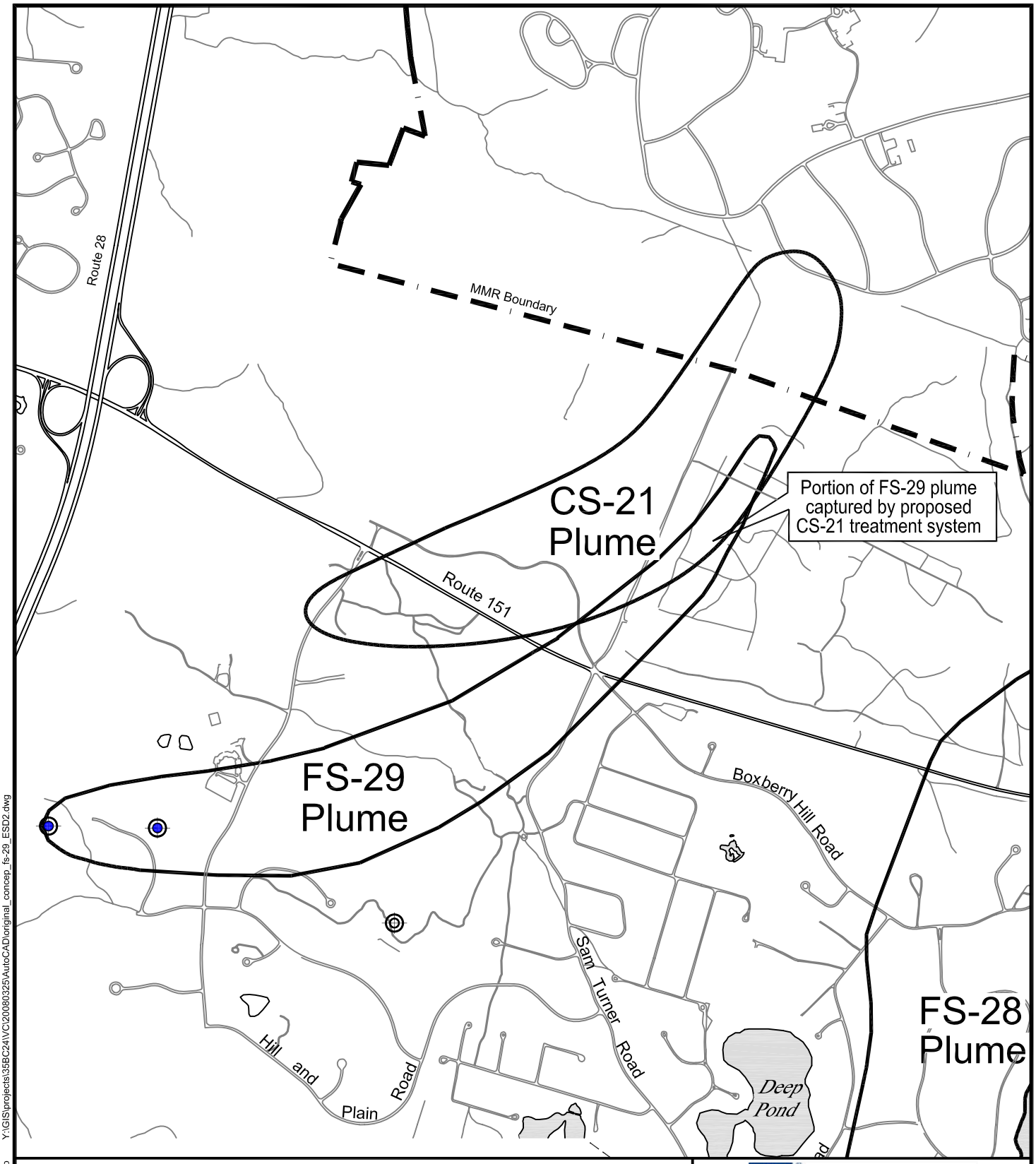
Original Conceptual Designs for the CS-4, CS-20 and CS-21 Remedy

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuito DATE: 3/24/2008

Figure 2-3

Y:\GIS\projects\35BC24\VC\20070324\ArcGIS\cs4_cs20_remedy_ESD2.mxd



Legend

1998 Plume Contour

Proposed Extraction Well

Irrigation Well

0 1500

Scale in Feet

JACOBS

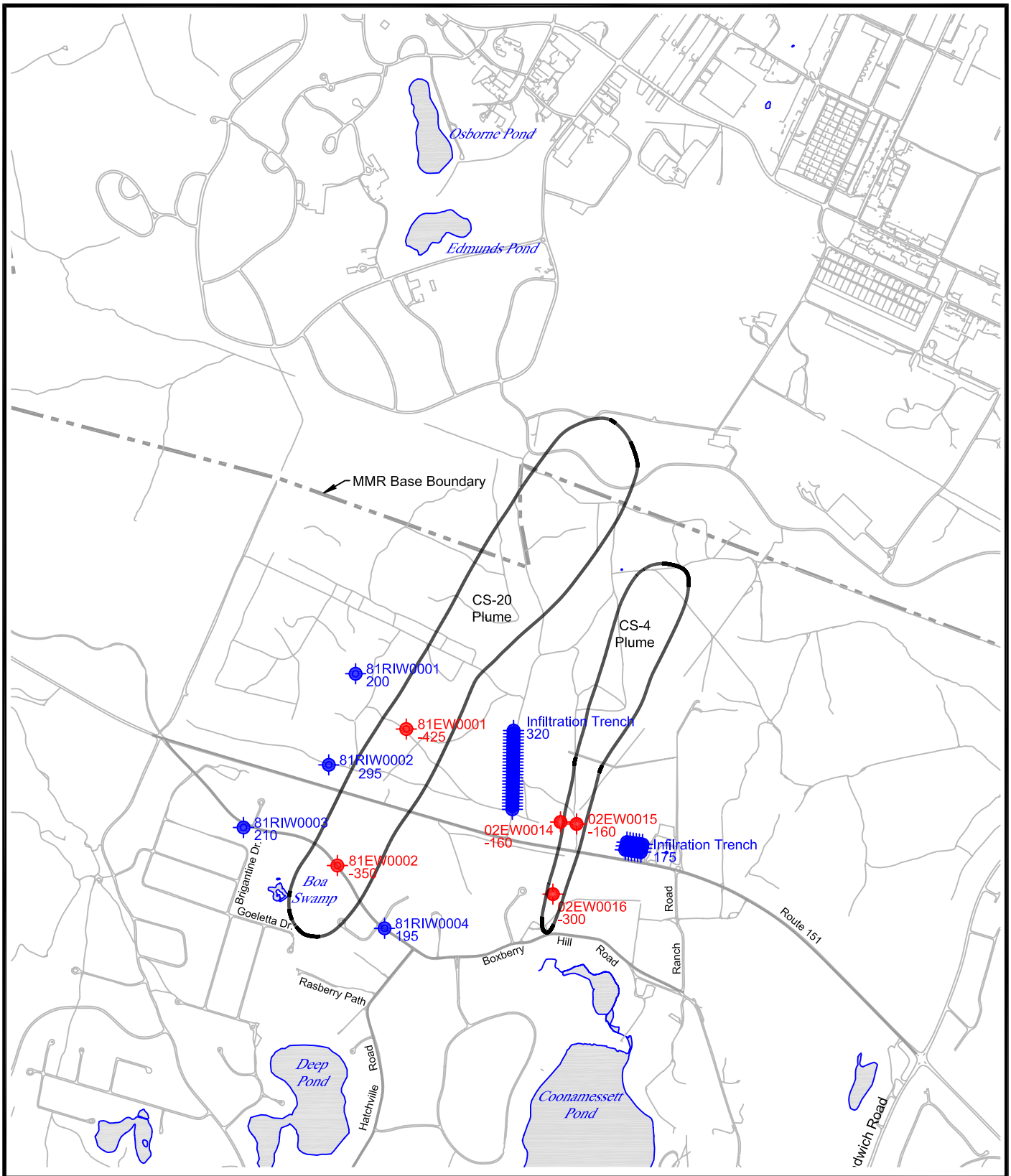
Original Conceptual Design for the FS-29 Remedy

Massachusetts Military Reservation
Cape Cod, Massachusetts

3/24/2008 jp

Figure 2-4

last modified: 03/25/08 printed: 03/25/08 by jp Y:\GIS\projects\35BC241V\20080325\AutoCAD\original_concep_fs-29_ESD2.dwg



Legend

-295 Extraction Well (with flow rate in gallons per minute)

225 Reinjection Well (with flow rate in gallons per minute)

Infiltration Gallery (with flow rate in gallons per minute)

Plume Contour (PCE, TCE MCL = 5.0 µg/L)

0 1750

Scale in Feet

JACOBS

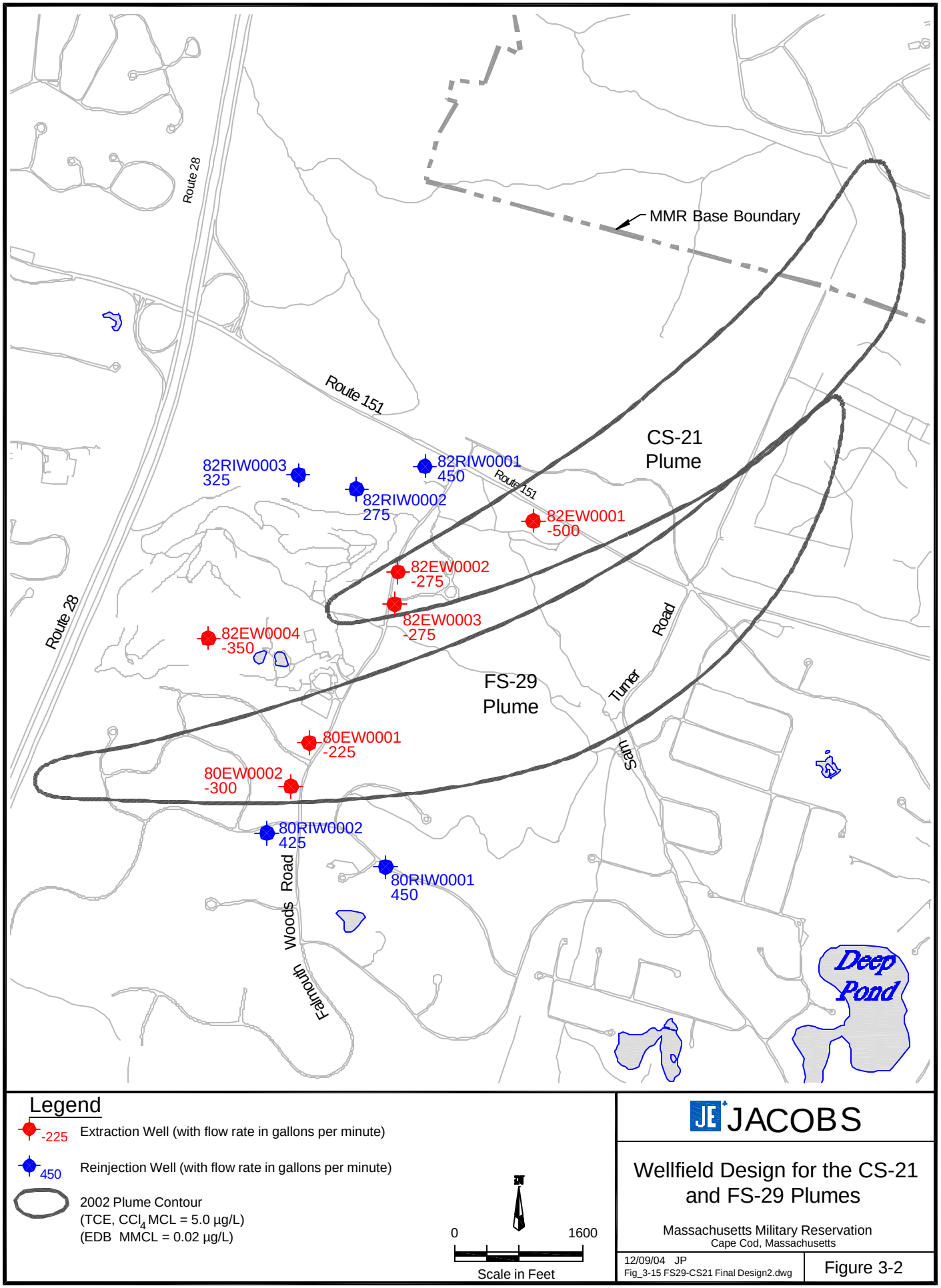
Final Wellfield Design for the CS-4 and CS-20 Plumes

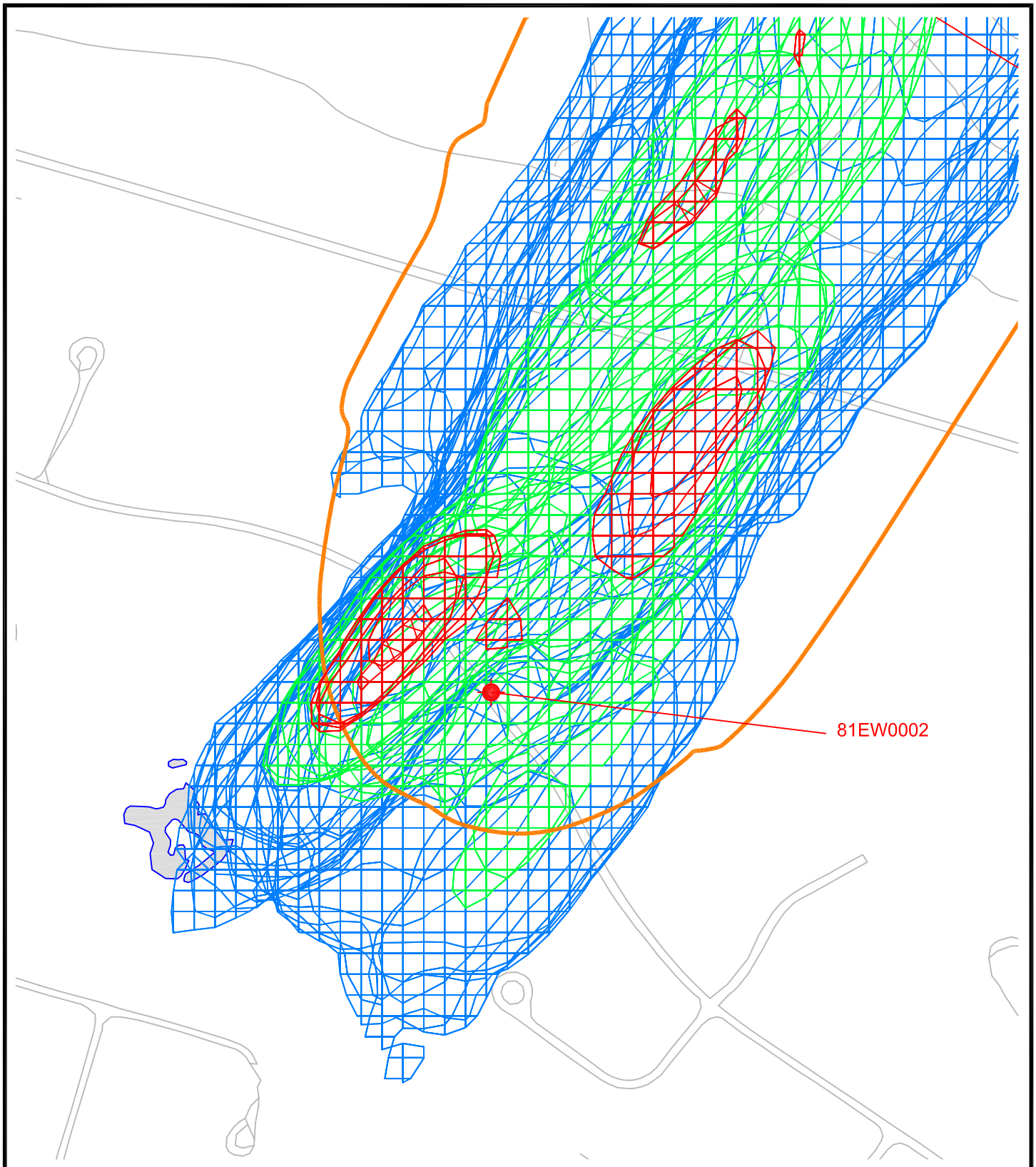
Massachusetts Military Reservation
Cape Cod, Massachusetts

03/05/08 JP
cs4_cs20_final_design_ESD2.dwg

Figure 3-1

last modified: 03/05/08 printed: 05/29/08 by jp Y:\GIS\projects\35BC24\VC\20080305\AutoCAD\cs4_cs20_final_design_ESD2.dwg


Route 28
MMR Base Boundary
Route 151
CS-21
Plume
82RIW0003
325
82RIW0001
450
Route 151
82RIW0002
275
82EW0001
-500
82EW0002
-275
82EW0003
-275
Route 28
82EW0004
-350
Road
Turner
FS-29
Plume
80EW0001
-225
Sam
80EW0002
-300
80RIW0002
425
80RIW0001
450
Woods Road
Falmouth
Deep
Pond
Legend
-225
Extraction Well (with flow rate in gallons per minute)
450
Reinjection Well (with flow rate in gallons per minute)
2002 Plume Contour
(TCE, CCl4 MCL = 5.0 µg/L)
(EDB MMCL = 0.02 µg/L)
0
1600
Scale in Feet
JACOBS
Wellfield Design for the CS-21 and FS-29 Plumes
Massachusetts Military Reservation
Cape Cod, Massachusetts
12/09/04 JP
Fig_3-15 FS29-CS21 Final Design2.dwg
Figure 3-2



Legend

CS-20 2006 PCE/TCE plume shell concentrations

5.0 - 20.0 µg/L

20.0 - 50.0 µg/L

> 50.0 µg/L

extraction well

320 gpm capture zone

0 200

Scale in Feet

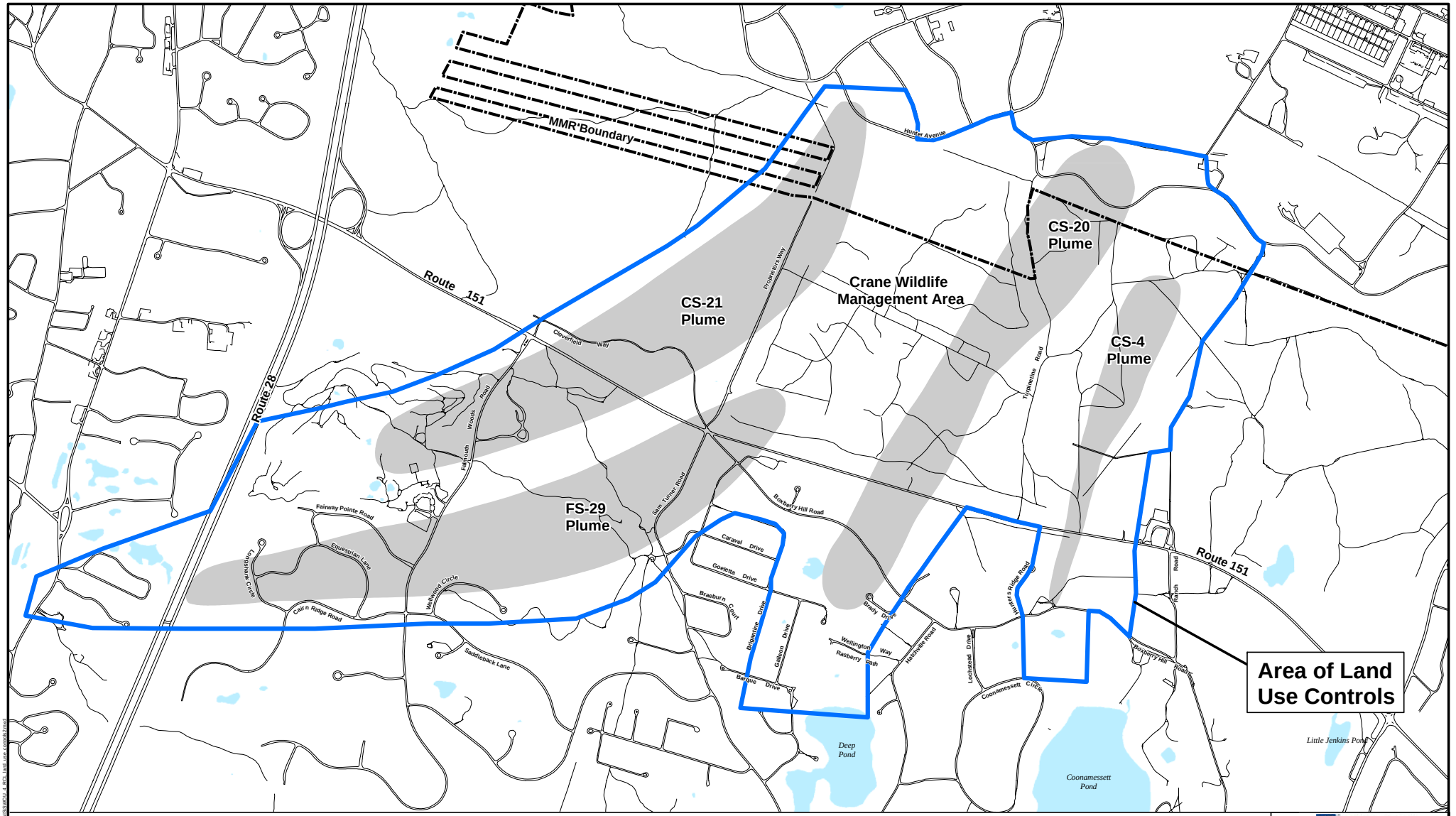
JACOBS

CS-20 Capture Zone with 81EW0002 Pumping at 320 gpm

Massachusetts Military Reservation
Cape Cod, Massachusetts

02/05/07
CS20_Capt_Zones4.dwg

Figure 3-3



Legend

2006 Plume Contour
(CCl_4, TCE, PCE MCL = 5.0 µg/L)
(EDB MMCL = 0.02 µg/L)

(M)MCL = (Massachusetts) maximum contaminant level

CCl_4 = carbon tetrachloride

PCE = tetrachloroethene

TCE = trichloroethene

EDB = ethylene dibromide

Area of Land Use Controls

N

0 625 1,250 Feet

1: 12,000

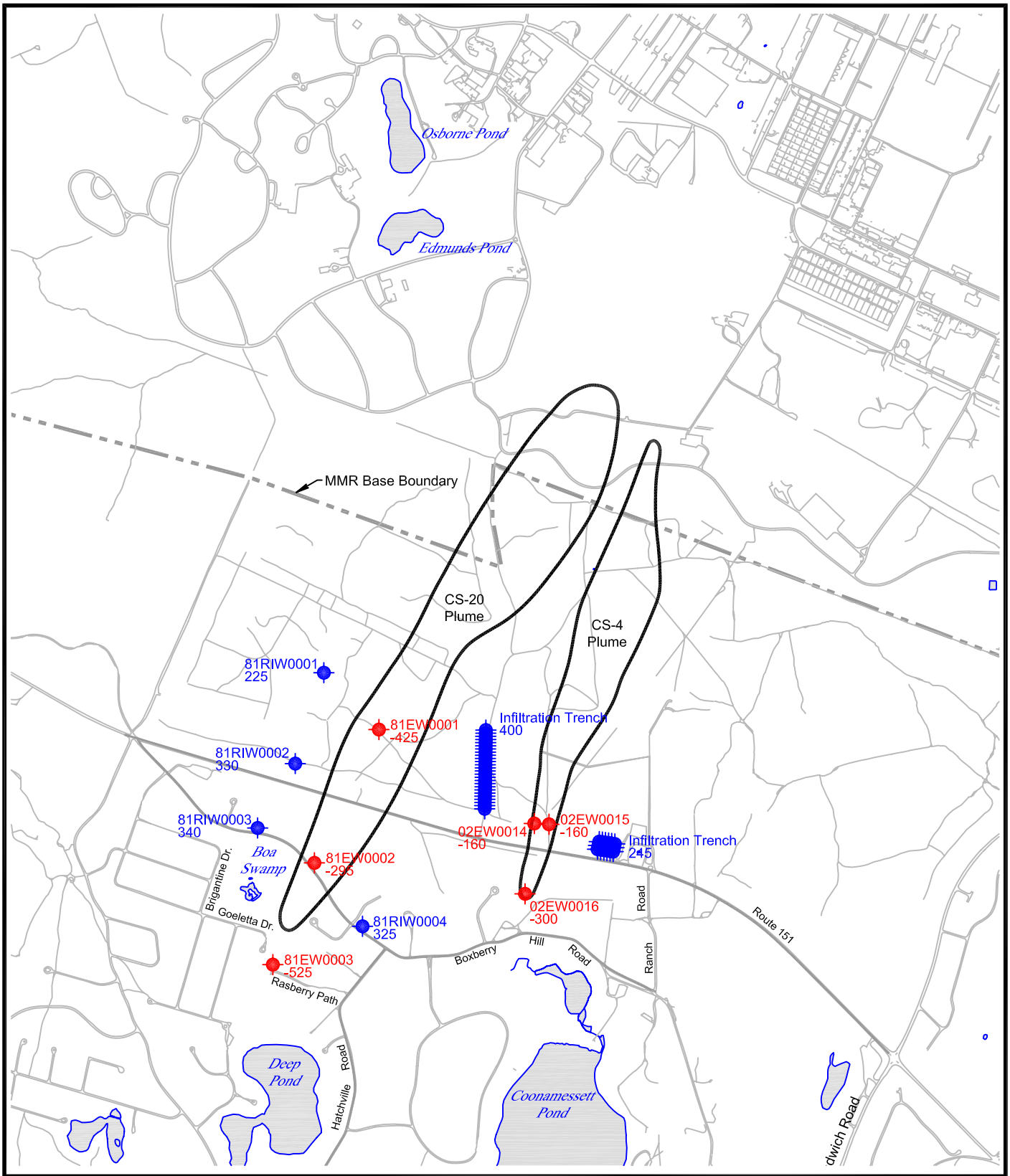
JE JACOBS

Area of Land Use Controls in the Southwest Plumes Area

Massachusetts Military Reservation
Cape Cod, Massachusetts

NAME: jpiccuto DATE: 1/24/2008

Figure 3-4



Legend

-295 Extraction Well (with flow rate in gallons per minute)

225 Reinjection Well (with flow rate in gallons per minute)

Infiltration Gallery (with flow rate in gallons per minute)

2002 Plume Contour (PCE, TCE MCL = 5.0 µg/L)

0 1750

Scale in Feet

JACOBS

Preliminary Wellfield Design for the CS-4 and CS-20 Plumes

Massachusetts Military Reservation
Cape Cod, Massachusetts

03/25/08 JP
cs4_cs20_pre_design_ESD3.dwg

Figure 3-5

last modified: 03/25/08 printed: 03/25/08 by jp Y:\GIS\projects\35BC24\VC\20080325\AutoCAD\cs4_cs20_pre_design_ESD3.dwg

APPENDIX A

FALMOUTH BOARD OF HEALTH WATER 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

George Heufelder

Arthur Vidal III

John Waterbury

John Waterbury

APPENDIX B

CS-20 LEADING EDGE

CHRONOLOGY OF EVENTS

CS-20 Leading Edge Investigation
Chronology of Events

- **July 2005:** AFCEE updates Senior Management Board on difficulty regarding access for the third extraction well for CS-20. AFCEE agrees to collect additional data to assess effects of deleting the planned extraction well.

- **September/October 2005:** AFCEE conducts six groundwater screening drive-points along Boxberry Hill Road (81DP1001-1006). Data shown in Tables B-1 through B-6 presented to EPA and MassDEP.

- **February 2006:** AFCEE conducts groundwater screening to bedrock at Goeletta Drive and installs 2 monitoring wells (81MW0018A/B). Data shown in Table B-7 presented to EPA and MassDEP

- **May 2006:** AFCEE presents results of data collection and updated model for CS-20 to the Senior Management Board (Attachment A).

- **October 2006:** AFCEE conducts additional groundwater screening drive-point more west along Goeletta Drive. Data presented to EPA and MassDEP for entire CS-20 leading edge area (Table B-8).

- **November 2006 - January 2007**: AFCEE receives concurrence from EPA, MassDEP, and Senior Management Board to not install a third extraction well. An ESD will be required along with continued monitoring in toe area.

Table B-1
Preliminary Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1001

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	EDB (µg/L) MMCL = 0.02	1,1,1-Trichloroethane (µg/L) MCL = 200
A	10/4/2005	85	90	87.5	9.5	ND	ND	ND	ND	ND
B		95	100	97.5	-0.5	BRL	ND	ND	ND	ND
C		105	110	107.5	-10.5	BRL	ND	ND	ND	ND
		115	120	117.5	-20.5	NS	NS	NS	NS	ND
D		125	130	127.5	-30.5	BRL	ND	ND	ND	ND
E	10/5/2005	135	140	137.5	-40.5	BRL	ND	ND	ND	ND
F		145	150	147.5	-50.5	**6.2**	ND	ND	ND	BRL
G		155	160	157.5	-60.5	**13.5**	ND	ND	ND	BRL
H		165	170	167.5	-70.5	**10.1**	ND	ND	ND	BRL
I	10/6/2005	175	180	177.5	-80.5	BRL	ND	ND	ND	ND
J		182	185	183.5	-86.5	ND	ND	ND	ND	ND

Notes:
BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = maximum contaminant level
MMCL = Massachusetts MCL
ND = not detected
NS = not sampled. Sample could not be obtained due to lithology.
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Bold value indicates standard exceedance
Analytical sampling methods for the specified parameters: VOC (8260B); EDB (E504.1)
Approximate elevation of ground surface is 97 ft msl.
Start Date - 10/4/05, Finish Date - 10/6/05.
Samples were analyzed at the onsite Groundwater Analytical laboratory.
Boring refusal was obtained at 185 ft bgs (~ -88 ft msl)

Table B-2
Preliminary Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1002

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	EDB (µg/L) MMCL = 0.02	1,1,1-Trichloroethane (µg/L) MCL = 200
A	9/29/2005	85	90	87.5	10.5	ND	ND	ND	ND	ND
B		95	100	97.5	0.5	ND	ND	ND	ND	ND
C		105	110	107.5	-9.5	ND	ND	ND	ND	ND
D		115	120	117.5	-19.5	ND	ND	ND	ND	ND
E	9/30/2005	125	130	127.5	-29.5	BRL	ND	ND	ND	ND
F		135	140	137.5	-39.5	1.7	ND	ND	ND	ND
G		145	150	147.5	-49.5	4.5	ND	ND	ND	ND
H		155	160	157.5	-59.5	**14.5**	ND	ND	ND	BRL
I		165	170	167.5	-69.5	**21.8**	ND	ND	ND	BRL
J	10/3/2005	170	175	172.5	-74.5	**31.5**	ND	ND	ND	1.2

Notes
BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = maximum contaminant level
MMCL = Massachusetts MCL
ND = not detected
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Bold value indicates standard exceedance
Analytical sampling methods for the specified parameters: VOC (8260B); EDB (E504.1)
Approximate elevation of ground surface is 98 ft msl.
Start Date - 9/29/05, Finish Date - 10/03/05.
Samples were analyzed at the onsite Groundwater Analytical laboratory.
Samples were analyzed at the onsite Groundwater Analytical laboratory.

Table B-3
Preliminary Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1003

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	EDB (µg/L) MMCL = 0.02	1,1-dichloroethene (µg/L) MCL = 7	1,1,1-Trichloroethane (µg/L) MCL = 200
A	9/26/2005	85	90	87.5	13.5	ND	ND	ND	ND	ND	ND
B		95	100	97.5	3.5	ND	ND	ND	ND	ND	ND
C		105	110	107.5	-6.5	ND	ND	ND	ND	ND	ND
D		115	120	117.5	-16.5	**6.6**	ND	ND	ND	ND	BRL
E	9/27/2005	125	130	127.5	-26.5	**21.3**	ND	ND	ND	ND	1.8
F		135	140	137.5	-36.5	**23.4**	BRL	ND	ND	ND	1.7
G		145	150	147.5	-46.5	**35.2**	BRL	BRL	BRL	BRL	3.8
H		155	160	157.5	-56.5	**43.1**	BRL	BRL	BRL	1.6	6
I		165	170	167.5	-66.5	**15**	BRL	BRL	ND	BRL	3.3
J	9/28/2005	175	180	177.5	-76.5	**29.1**	BRL	BRL	BRL	1.3	5.3
		185	190	187.5	-86.5	NS	NS	NS	NS	NS	NS

Notes:
BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = maximum contaminant level
MMCL = Massachusetts MCL
ND = not detected
NS = not sampled. Sample could not be obtained due to lithology.
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Bold value indicates standard exceedance
Analytical sampling methods for the specified parameters: VOC (8260B); EDB (E504.1)
Approximate elevation of ground surface is 101 ft msl.
Start Date - 9/26/05, Finish Date - 9/28/05.
Samples were analyzed at the onsite Groundwater Analytical laboratory.
Boring refusal was obtained at 190 ft bgs (~ -89 ft msl)

Table B-4
Preliminary Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1004

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	EDB (µg/L) MMCL = 0.02	1,1-dichloroethene (µg/L) MCL = 7	1,1,1-Trichloroethane (µg/L) MCL = 200	1,1-dichloroethane (µg/L) ORSG = 70
A	9/21/2005	85	90	87.5	13.5	ND	ND	ND	ND	ND	ND	ND
B		95	100	97.5	3.5	ND	ND	ND	ND	ND	ND	ND
C	9/22/2005	105	110	107.5	-6.5	1.1	ND	ND	ND	ND	ND	ND
D		115	120	117.5	-16.5	**11.6**	ND	ND	ND	ND	1.1	ND
E		125	130	127.5	-26.5	**98.1**	ND	ND	ND	1.9	11.1	BRL
F		135	140	137.5	-36.5	**54.6**	BRL	ND	ND	1.3	6.9	ND
G		145	150	147.5	-46.5	**35**	BRL	BRL	0.01	1.9	6.1	ND
H		155	160	157.5	-56.5	**25**	BRL	BRL	BRL	1.1	4.7	BRL
I	9/23/2005	165	170	167.5	-66.5	**17.4**	1.2	1.1	BRL	1.4	1.1	BRL
J		175	180	177.5	-76.5	3.6	BRL	ND	BRL	1.3	3.8	BRL

Notes:
BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
ft bgs = feet below ground surface
ft msl = feet mean sea leve
MCL = maximum contaminant level
MMCL = Massachusetts MCL
ND = not detected
ORSG = Office of Research and Standards Guidelines (MADEP)
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Bold value indicates standard exceedance
Analytical sampling methods for the specified parameters: VOC (8260B); EDB (E504.1
Approximate elevation of ground surface is 101 ft msl
Start Date - 9/21/05, Finish Date - 9/23/05.
Samples were analyzed at the onsite Groundwater Analytical laboratory
Samples were analyzed at the onsite Groundwater Analytical laboratory

Table B-5
Preliminary Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1005

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	EDB (µg/L) MMCL = 0.02	1,1-dichloroethene (µg/L) MCL = 7	1,1,1-Trichloroethane (µg/L) MCL = 200	1,1-dichloroethane (µg/L) ORSG = 70
A	9/15/2005	85	90	87.5	13.5	ND	ND	ND	ND	ND	ND	ND
B	9/16/2005	95	100	97.5	3.5	ND	ND	ND	ND	ND	ND	ND
C		105	110	107.5	-6.5	ND	ND	ND	ND	ND	ND	ND
D		115	120	117.5	-16.5	ND	ND	ND	ND	ND	ND	ND
E		125	130	127.5	-26.5	ND	ND	ND	ND	ND	ND	ND
F		135	140	137.5	-36.5	ND	ND	ND	ND	BRL	1.9	ND
G		145	150	147.5	-46.5	BRL	ND	ND	ND	BRL	3.1	ND
H	9/19/2005	155	160	157.5	-56.5	1.6	ND	ND	ND	2.4	11.3	BRL
I		165	170	167.5	-66.5	ND	ND	BRL	ND	2.7	9.3	BRL
J		175	180	177.5	-76.5	ND	ND	BRL	ND	1.1	3.8	ND
K		185	190	187.5	-86.5	BRL	ND	BRL	ND	1.3	6.5	ND
L	9/20/2005	195	200	197.5	-96.5	BRL	ND	ND	ND	3.2	9.1	BRL

Notes:

BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = maximum contaminant level
MMCL = Massachusetts MCL
ND = not detected
ORSG = Office of Research and Standards Guidelines (MADEP)
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Analytical sampling methods for the specified parameters: VOC (8260B); EDB (E504.1)
Approximate elevation of ground surface is 101 ft msl.
Start Date - 9/15/05, Finish Date - 9/20/05.
Samples were analyzed at the onsite Groundwater Analytical laboratory.
Boring refusal was obtained at 200 ft bgs (~ -99 ft msl)

Table B-6
Preliminary Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1006

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	EDB (µg/L) MMCL = 0.02
A	10/18/2005	85	90	87.5	4.5	ND	ND	ND	ND
B		95	100	97.5	-5.5	BRL	ND	ND	ND
C		105	110	107.5	-15.5	NS	NS	NS	NS
D		115	120	117.5	-25.5	NS	NS	NS	NS
E		125	130	127.5	-35.5	NS	NS	NS	NS
F	10/20/2005	135	140	137.5	-45.5	NS	NS	NS	NS
G		145	150	147.5	-55.5	NS	NS	NS	NS
H		155	160	157.5	-65.5	NS	NS	NS	NS

Notes:
BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = maximum contaminant level
MMCL = Massachusetts MCL
ND = not detected
ORSG = Office of Research and Standards Guidelines (MADEP)
PCE = tetrachloroethene
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Analytical sampling methods for the specified parameters: VOC (8260B); EDB (E504.1)
Approximate elevation of ground surface is 92 ft msl.
Start Date - 10/18/05, Finish Date - 10/20/05.
Samples were analyzed at the onsite Groundwater Analytical laboratory.
Boring refusal was obtained at 155 ft bgs (~ -63 ft msl)

Table B-7
Preliminary Borehole Groundwater Screening Results
CS-20 Drilling Program
Sonic Location 81MW0018A

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5	TCE (µg/L) MCL = 5	CCl4 (µg/L) MCL = 5	1,1,1-TCA (µg/L) MCL = 200	1,1-DCE (µg/L) MCL = 7	EDB (µg/L) MMCL = 0.02
A	2/6/2006	40	45	42.5	25.5	ND	ND	ND	ND	ND	ND
B		50	55	52.5	15.5	ND	ND	ND	ND	ND	ND
C	2/7/2006	60	65	62.5	5.5	ND	ND	ND	ND	ND	ND
D		70	75	72.5	-4.5	ND	ND	ND	ND	ND	ND
E		80	85	82.5	-14.5	ND	ND	ND	ND	ND	ND
F		90	95	92.5	-24.5	1.2	ND	ND	ND	ND	ND
G		100	105	102.5	-34.5	2.1	ND	ND	ND	ND	ND
H		110	115	112.5	-44.5	1.5	ND	ND	ND	ND	ND
I		120	125	122.5	-54.5	1.9	BRL	ND	ND	ND	ND
J		130	135	132.5	-64.5	BRL	BRL	BRL	ND	ND	ND
K		140	145	142.5	-74.5	ND	BRL	BRL	ND	ND	ND
L	2/8/2006	150	155	152.5	-84.5	ND	BRL	BRL	ND	ND	ND
M		160	165	162.5	-94.5	ND	BRL	BRL	ND	ND	ND
N		170	175	172.5	-104.5	ND	BRL	BRL	ND	ND	ND
O		180	185	182.5	-114.5	ND	1.1	BRL	ND	ND	ND
P		190	195	192.5	-124.5	ND	BRL	BRL	ND	ND	ND
Q		200	205	202.5	-134.5	BRL	BRL	BRL	BRL	ND	ND
R		210	215	212.5	-144.5	BRL	BRL	BRL	BRL	ND	ND
S	2/9/2006	220	225	222.5	-154.5	1.5	BRL	1.2	2.3	BRL	ND
T		230	235	232.5	-164.5	BRL	BRL	1.3	3.2	BRL	ND
U		240	245	242.5	-174.5	BRL	BRL	BRL	1.1	ND	BRL
V		250	255	252.5	-184.5	BRL	BRL	ND	BRL	ND	ND

Notes:
BOS = bottom of sample
BRL = below reporting limit (1 µg/L)
CCl_4 = carbon tetrachloride
EDB = ethylene dibromide
DCE = dichloroethene
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
MMCL = Massachusetts MCL
ND = not detected
PCE = tetrachloroethene
TCA = trichlorethane
TCE = trichloroethene
TOS = top of sample
µg/L = micrograms per liter

Analytical sampling methods for the specified parameters: VOC (SW846 8260B); EDB (EPA 504.1)
Estimated Ground surface elevation 68 ft msl.
Drilling Start Date - 01/06/06, Drilling Finish Date - 01/10/06
Sample intervals A-V were analyzed at the onsite laboratory.
Boring refusal was obtained at 259 ft bgs (~ -191 ft msl)
81MW0018A screen is set at 112 to 117 ft bgs (~ -44 to -49 ft msl).
81MW0018B screen is set at 218 to 223 ft bgs (~ -150 to -155 ft msl).

Borehole Groundwater Screening Results
CS-20 Direct Push Drilling Program
Direct Push Location 81DP1007

Sample Interval	Sample Date	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	PCE (µg/L) MCL = 5
A	10/9/2006	65	70	67.5	23.5	ND
B		75	80	77.5	13.5	ND
C		85	90	87.5	3.5	ND
D	10/10/2006	95	100	97.5	-6.5	ND
E		105	110	107.5	-16.5	ND
F		115	120	117.5	-26.5	ND
G		125	130	127.5	-36.5	ND
H		135	140	137.5	-46.5	ND
I		145	150	147.5	-56.5	ND
J	10/11/2006	155	160	157.5	-66.5	ND
K		165	170	167.5	-76.5	ND
		175	180	177.5	-86.5	NS
L		185	190	187.5	-96.5	ND
M	10/12/2006	195	200	197.5	-106.5	ND
N		205	210	207.5	-116.5	ND
O		214	219	216.5	-125.5	ND

Key:

BOS = bottom of sample
CS-20 = Chemical Spill-20
ft bgs = feet below ground surface
ft msl = feet mean sea level
MCL = Maximum Contaminant Level
ND = not detected
NS = not sampled due to lithology
PCE = tetrachloroethene
TOS = top of sample
µg/L = micrograms per liter

Notes:

Analytical sampling methods for the specified parameters: VOC (8260B).
Approximate elevation of ground surface is 91 ft msl.
Start Date - 10/09/05, Finish Date - 10/12/05.
Samples were analyzed at the onsite Groundwater Analytical Laboratory.
Boring refusal was obtained at 219 ft bgs (~ -128 ft msl).

ATTACHMENT A

CS-20 LEADING EDGE PRESENTATION

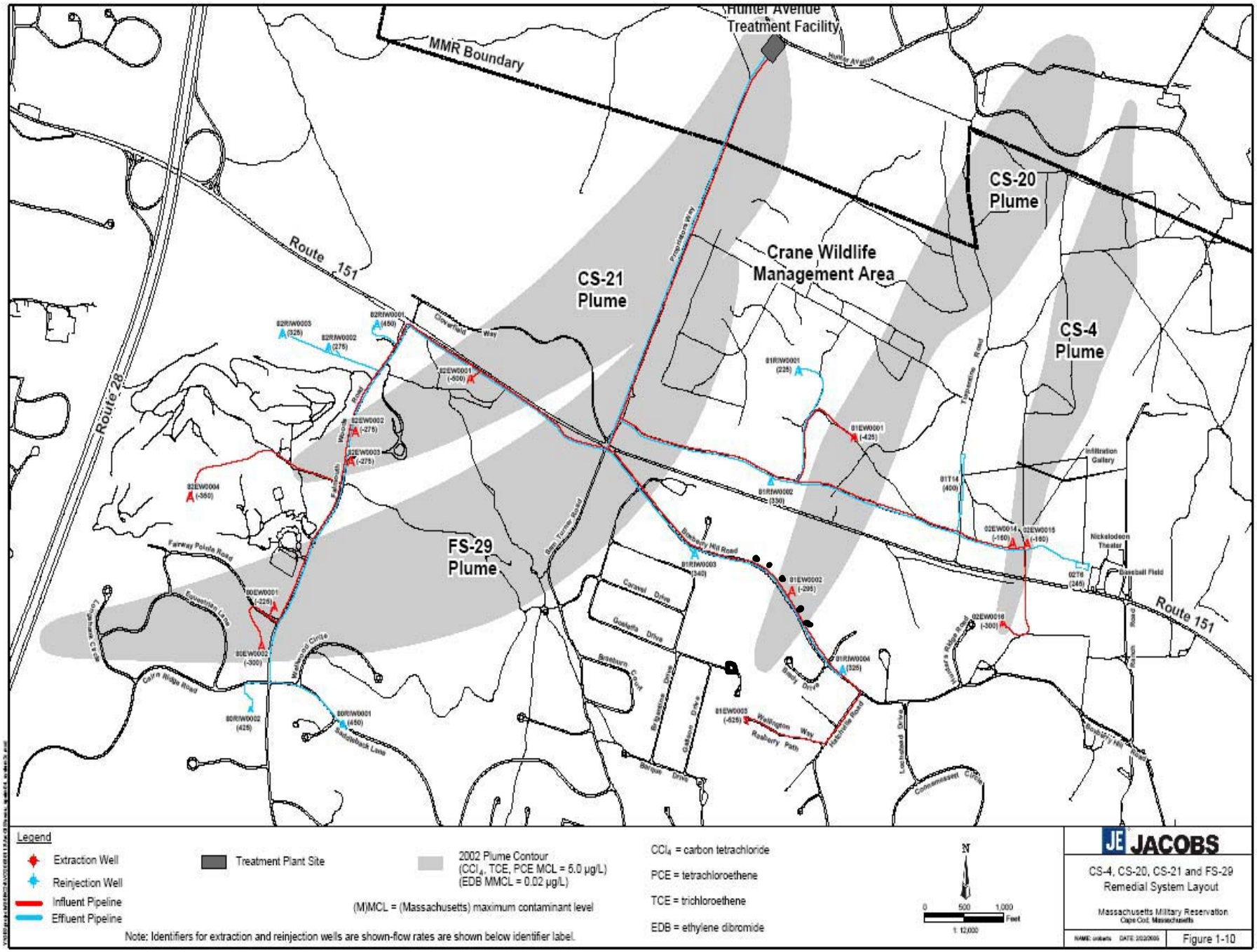
CS-20 Leading Edge

Jon Davis, AFCEE/MMR

Senior Management Board
May 24, 2006

Background

- Access difficult for third extraction well
- SMB requested additional data to make better-informed decision regarding fate of CS-20
- AFCEE gathered additional data
- AFCEE updated model to view CS-20 fate without third extraction well


Hunter Avenue Treatment Facility
MMR Boundary
Route 151
Route 28
CS-21 Plume
CS-20 Plume
CS-4 Plume
FS-29 Plume
Crane Wildlife Management Area
Infiltration Gallery
Nickelodeon Theater
Baseball Field
Legend
Extraction Well
Reinjection Well
Influent Pipeline
Effluent Pipeline
Treatment Plant Site
2002 Plume Contour
(CCl_4, TCE, PCE MCL = 5.0 µg/L)
(EDB MMCL = 0.02 µg/L)
(M)MCL = (Massachusetts) maximum contaminant level
CCl_4 = carbon tetrachloride
PCE = tetrachloroethene
TCE = trichloroethene
EDB = ethylene dibromide
Note: Identifiers for extraction and reinjection wells are shown-flow rates are shown below identifier label.
N
0 500 1,000 Feet
1:12,000
JACOBS
CS-4, CS-20, CS-21 and FS-29
Remedial System Layout
Massachusetts Military Reservation
Cape Cod, Massachusetts
Figure 1-10

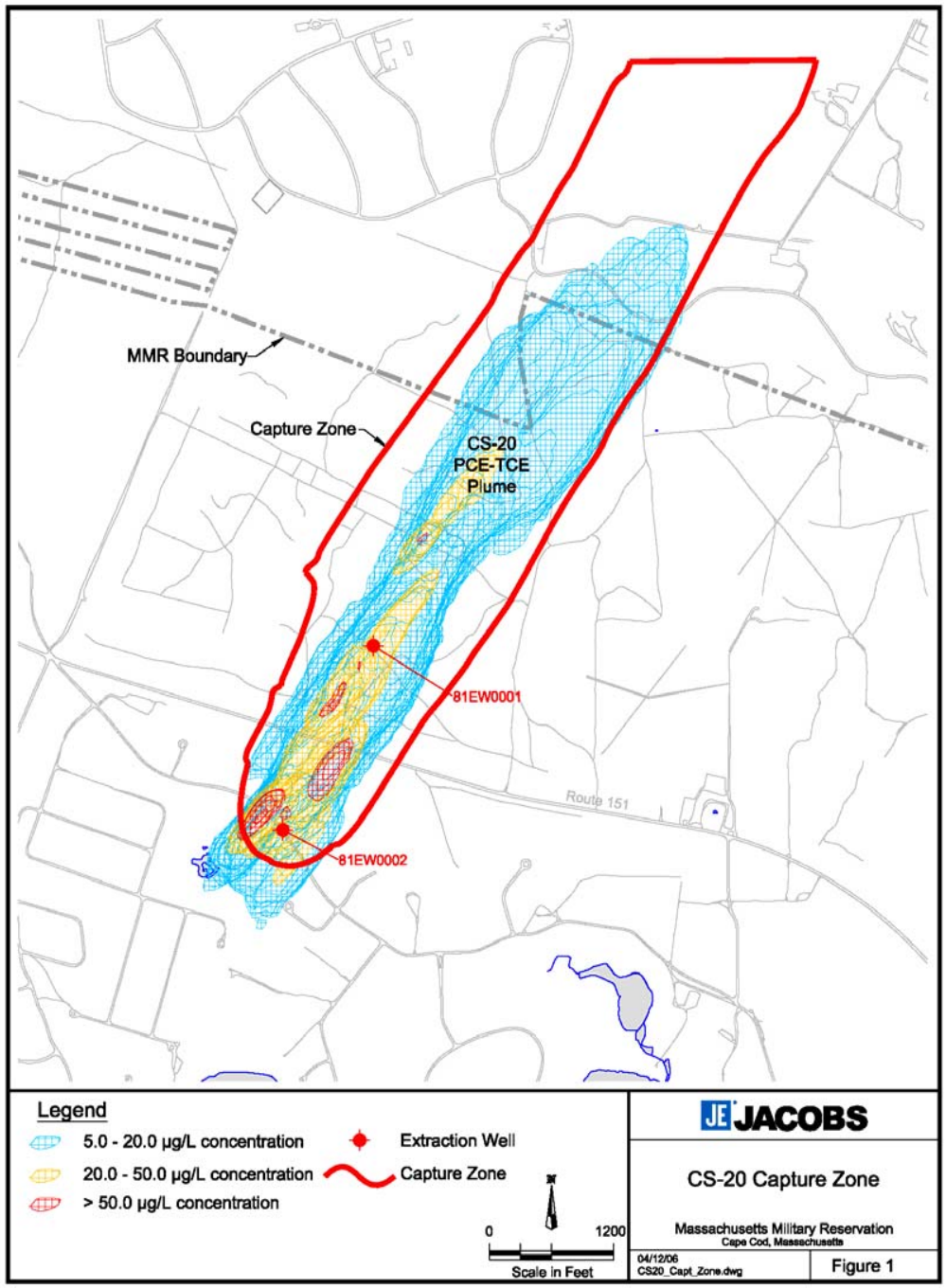
Additional Data

- Five drive-points along Boxberry Hill Road
  - Helped define width/depth/concentration range
- Sonic boring to bedrock at Goeletta Drive
  - No MCL exceedances

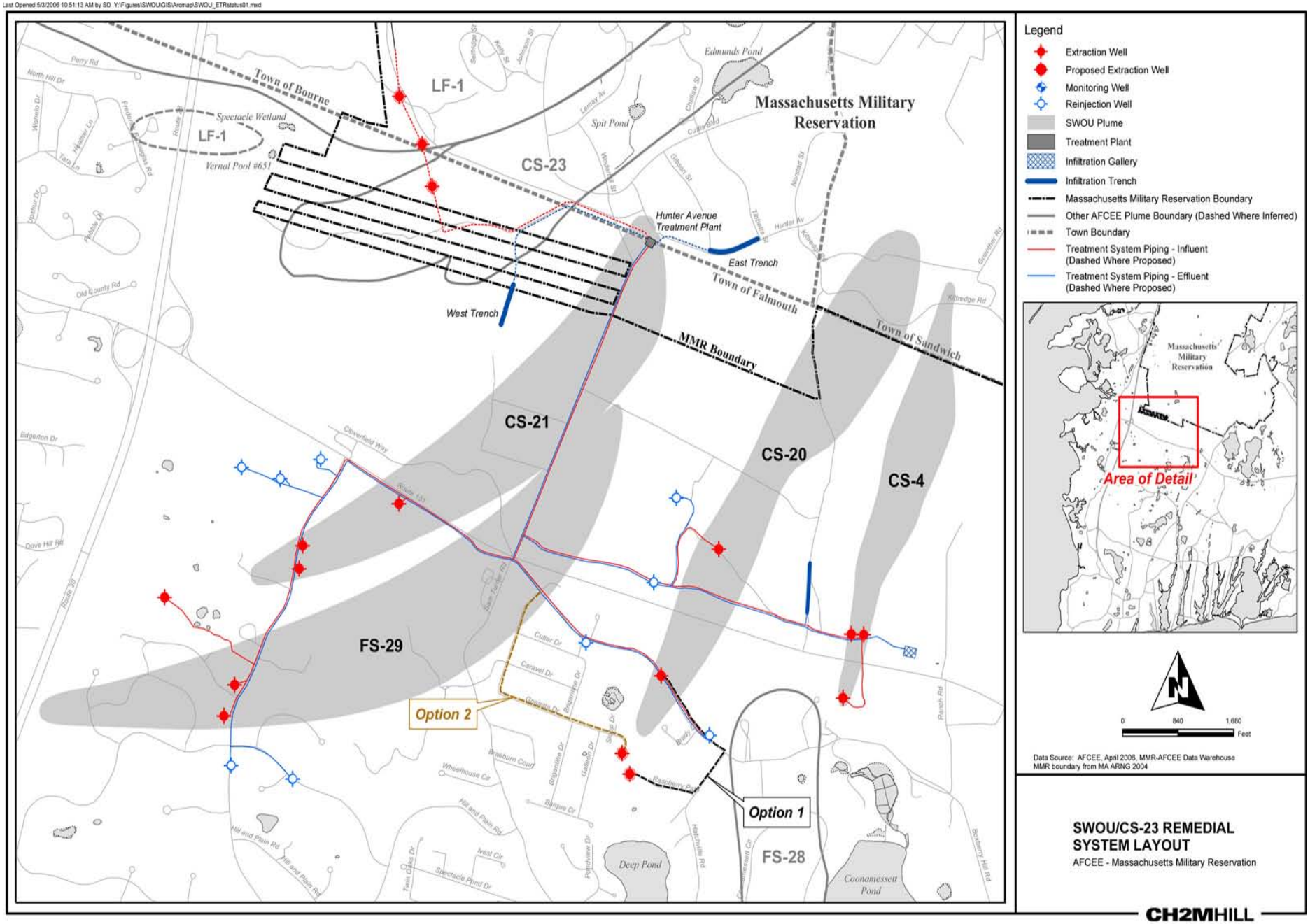
Current Status

- Modeling of uncaptured portion presented to regulators on 10 May 06
  - Internal discussions on-going

- Present to SMB at this meeting
  - Feedback regarding issue


MMR Boundary
Capture Zone
CS-20
PCE-TCE
Plume
81EW0001
81EW0002
Route 151
Legend
5.0 - 20.0 µg/L concentration
20.0 - 50.0 µg/L concentration
> 50.0 µg/L concentration
Extraction Well
Capture Zone
0
1200
Scale in Feet
JACOBS
CS-20 Capture Zone
Massachusetts Military Reservation
Cape Cod, Massachusetts
04/12/06
CS20_Capt_Zone.dwg
Figure 1

Last Opened 5/3/2006 10:51:13 AM by SD Y:\Figures\SWOU\GIS\Arcmap\SWOU_ETRstatus01.mxd



SWOU/CS-23 REMEDIAL SYSTEM LAYOUT

AFCEE - Massachusetts Military Reservation

CH2MHILL

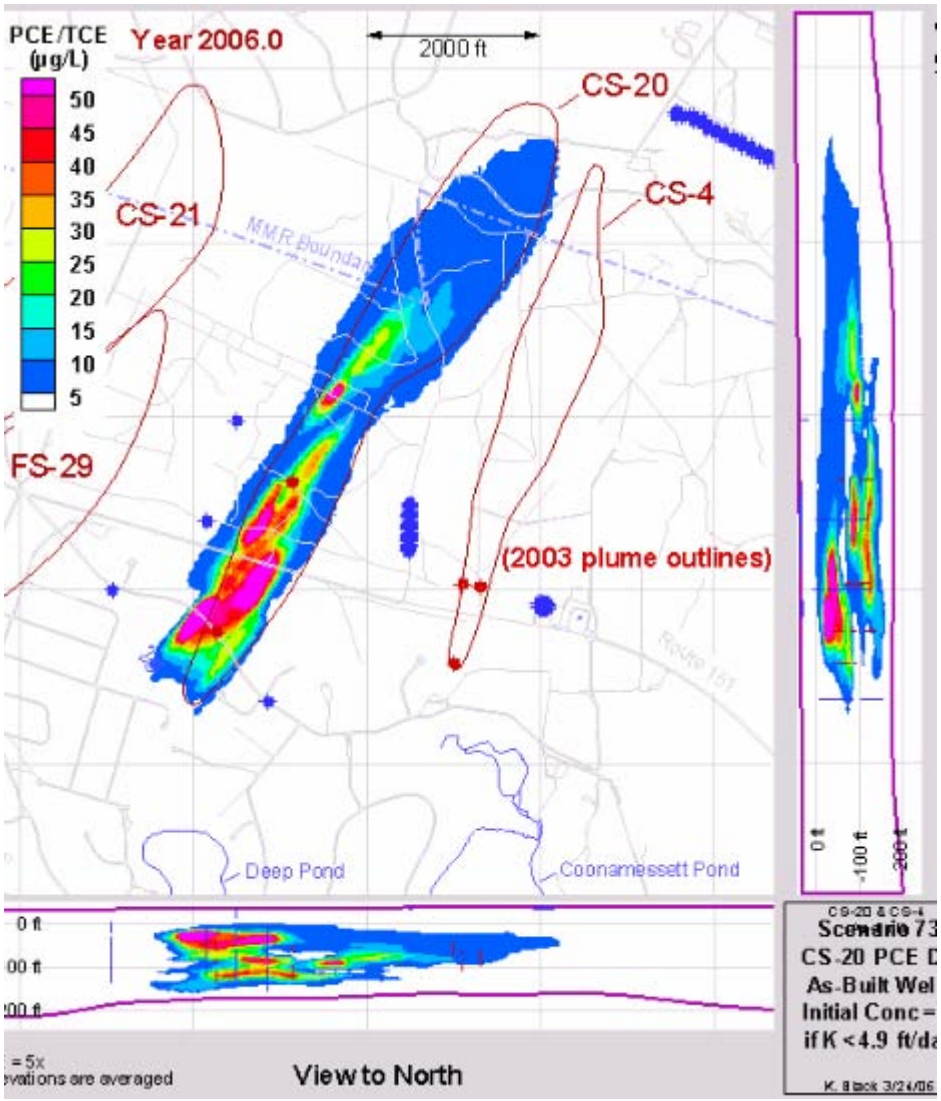
CS-20 Wellfield Comparison

	Total Mass at Start up (kg)	Mass Above MCL at Startup (kg)	Plume Clean Year (Entire)	Plume Clean Year (Toe Area)	Well Clean Year	Total Mass Captured by Well Clean Year (kg)	Percentage of Total Mass Captured by Well Clean Year
As-Built Conditions	72	63	2024	**2017**	2017	46	64%
As-Built Conditions with Goeletta Well	72	63	2022	**2011**	2017	57	80%

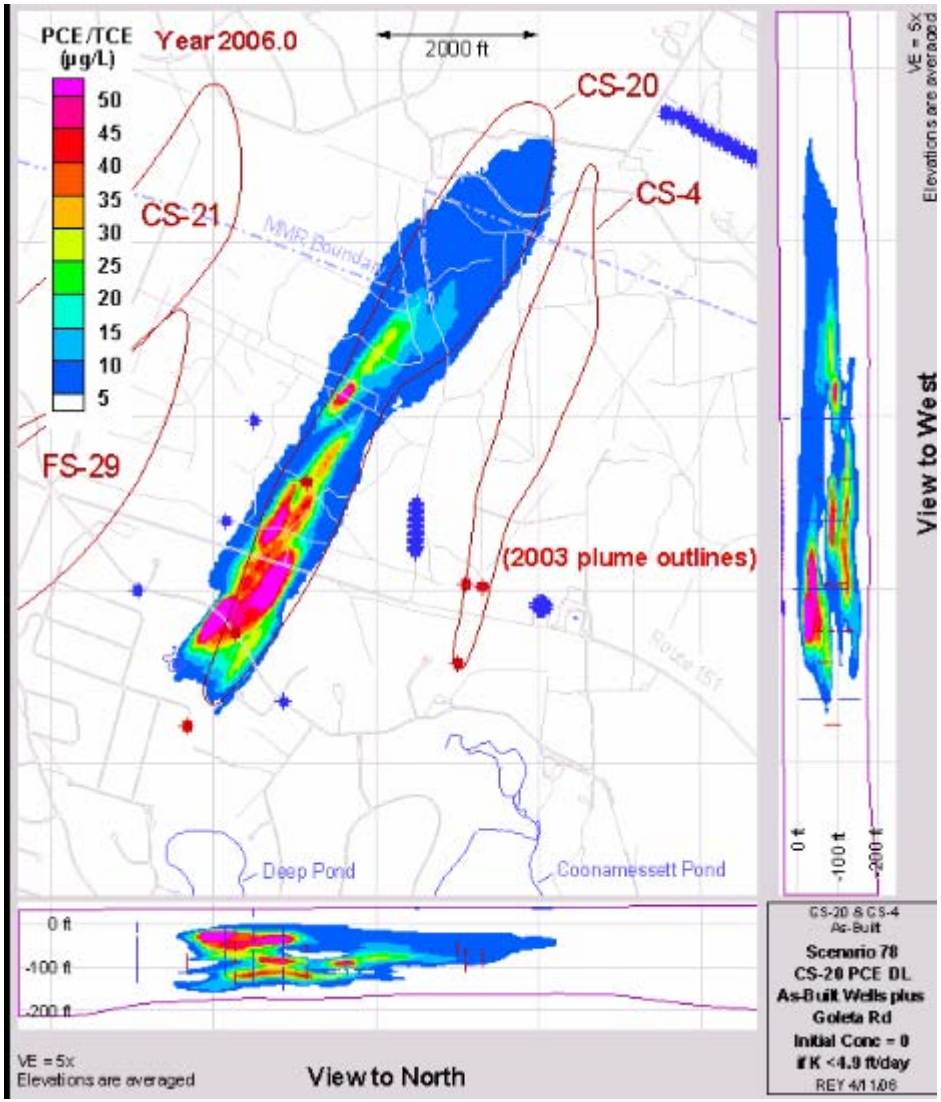
- Modeling Animations

Groundwater Modeling Animation

Existing CS-20 wellfield

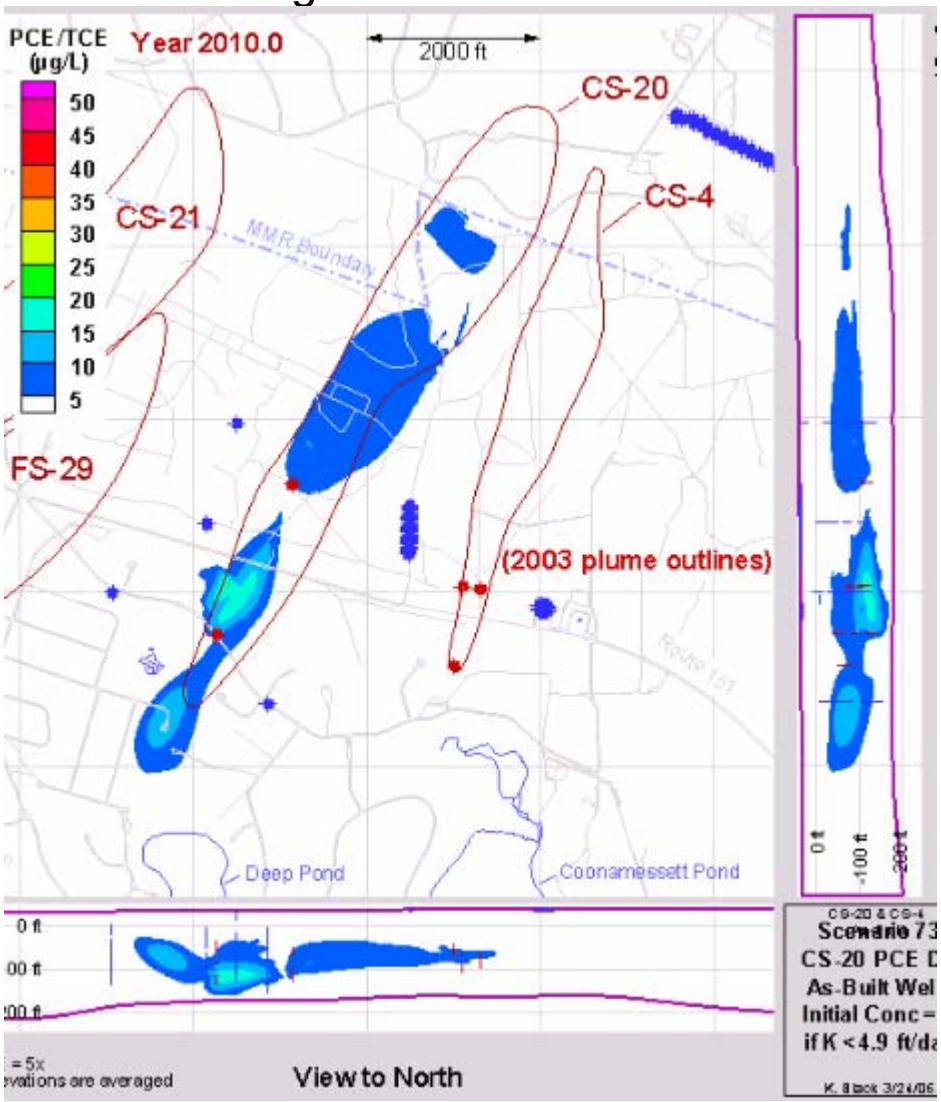


CS-20 wellfield with an EW on Goletta Dr.

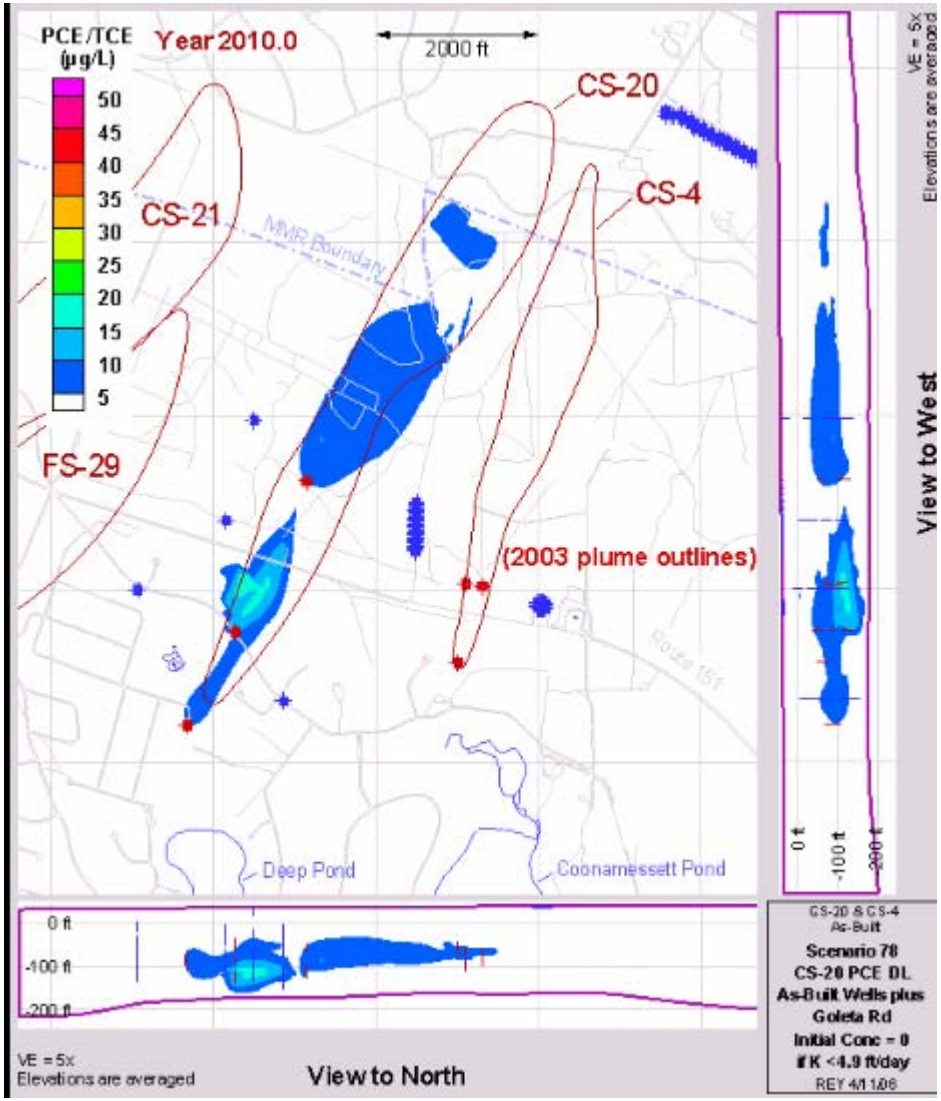


Groundwater Modeling Animation

Existing CS-20 wellfield

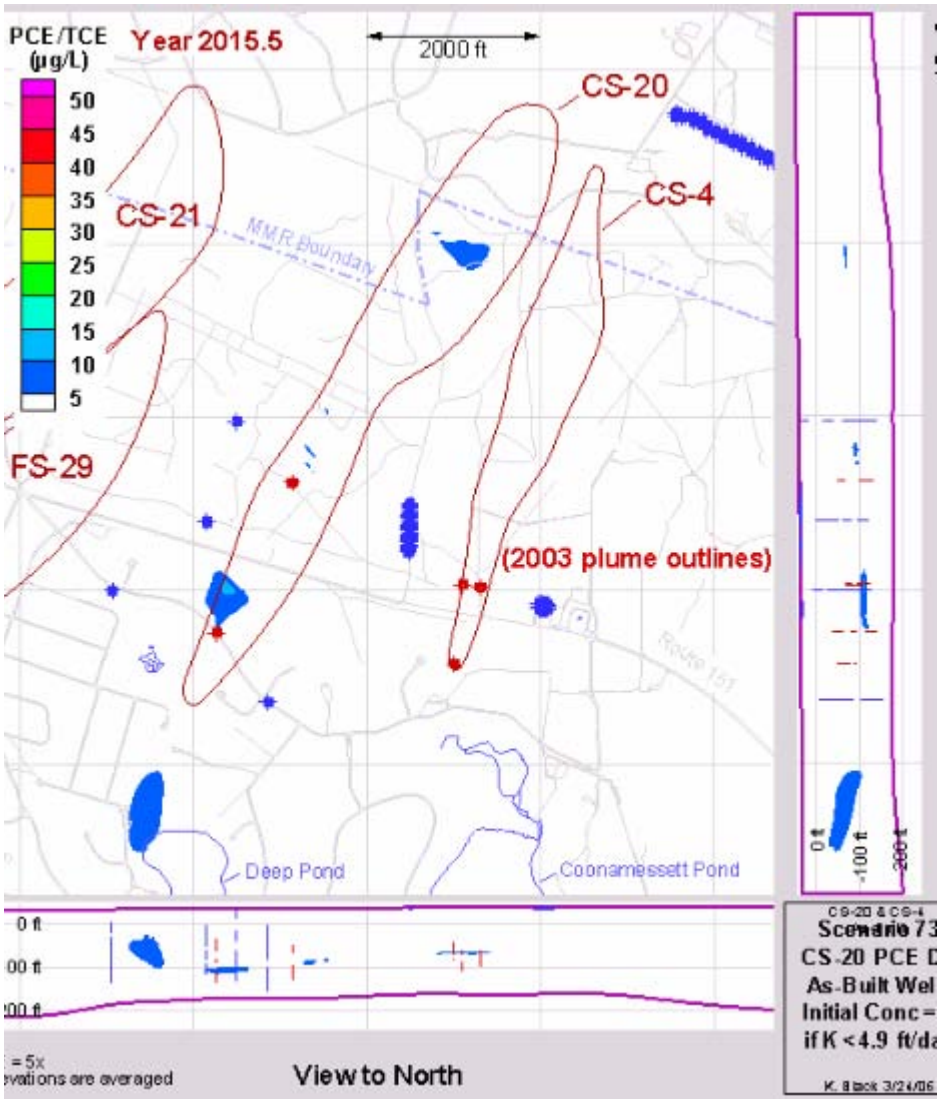


CS-20 wellfield with an EW on Goletta Dr.

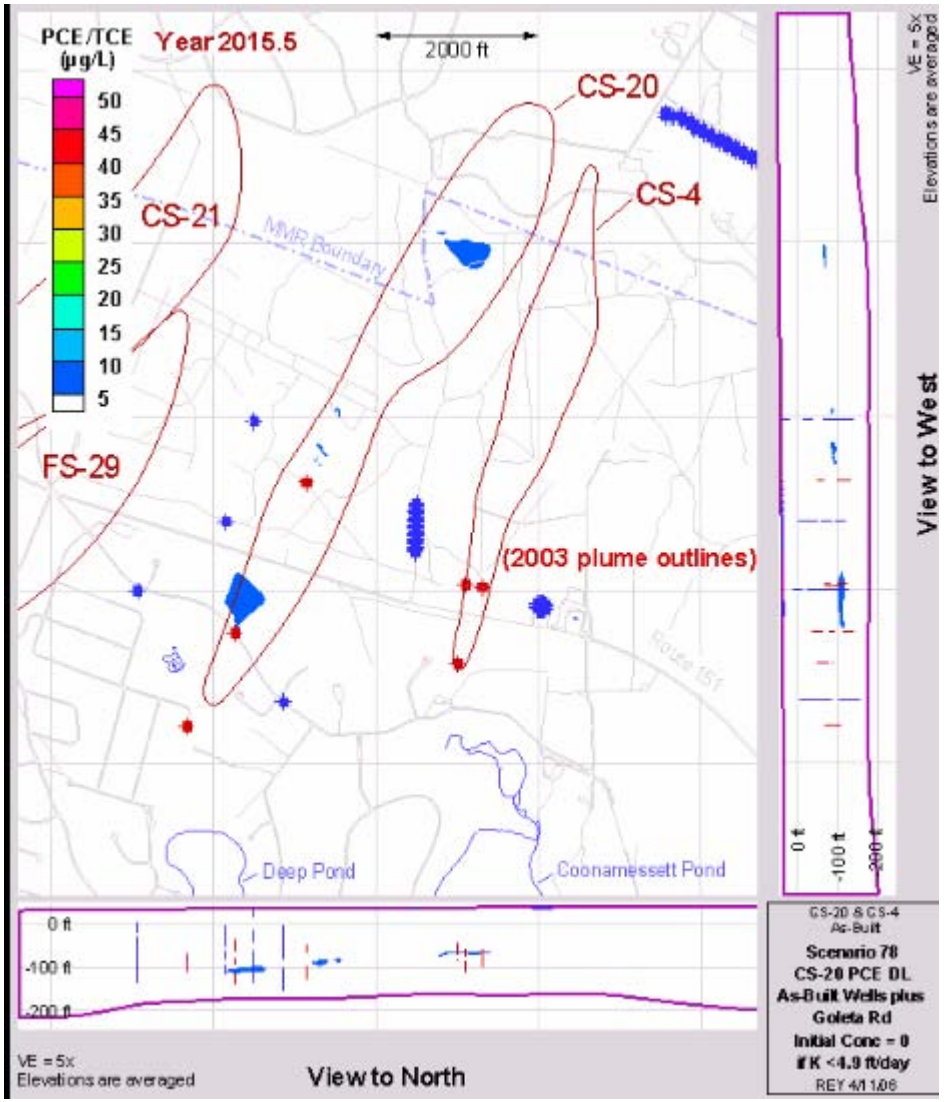


Groundwater Modeling Animation

Existing CS-20 wellfield



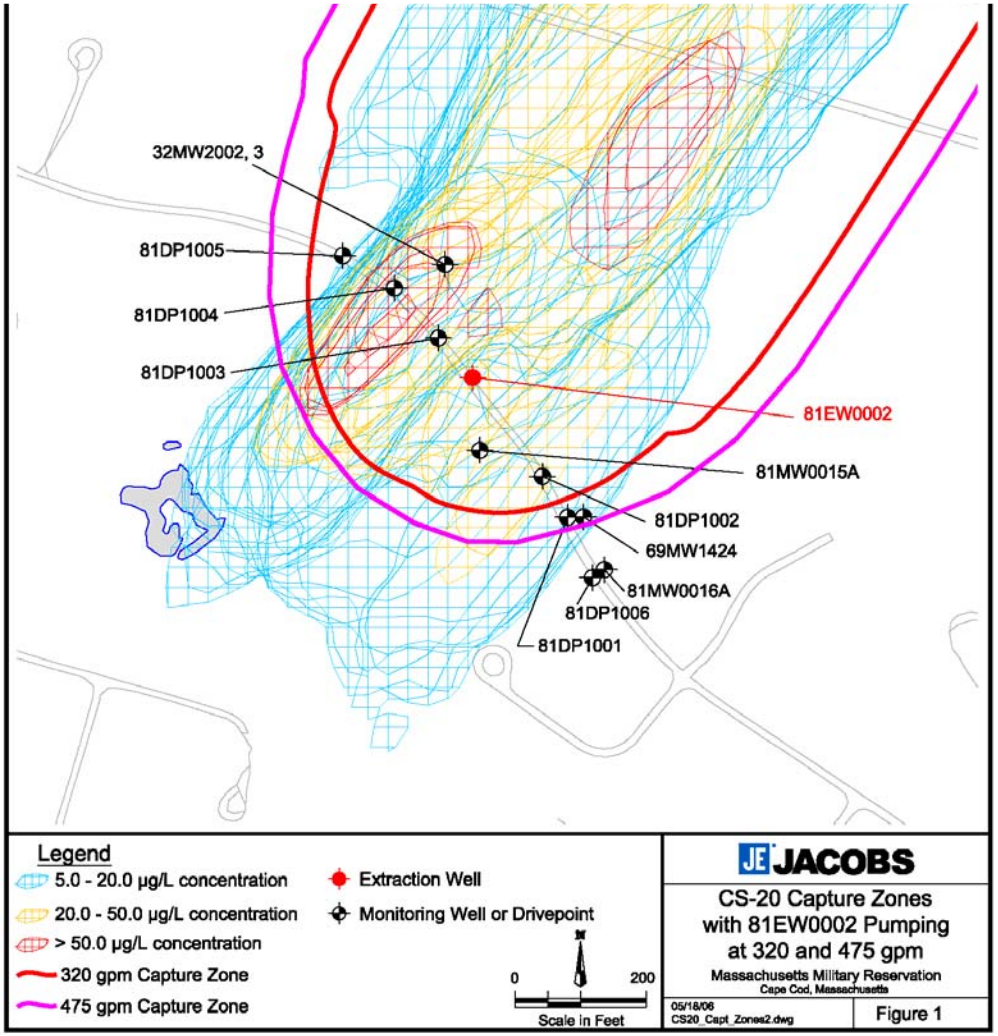
CS-20 wellfield with an EW on Goletta Dr.

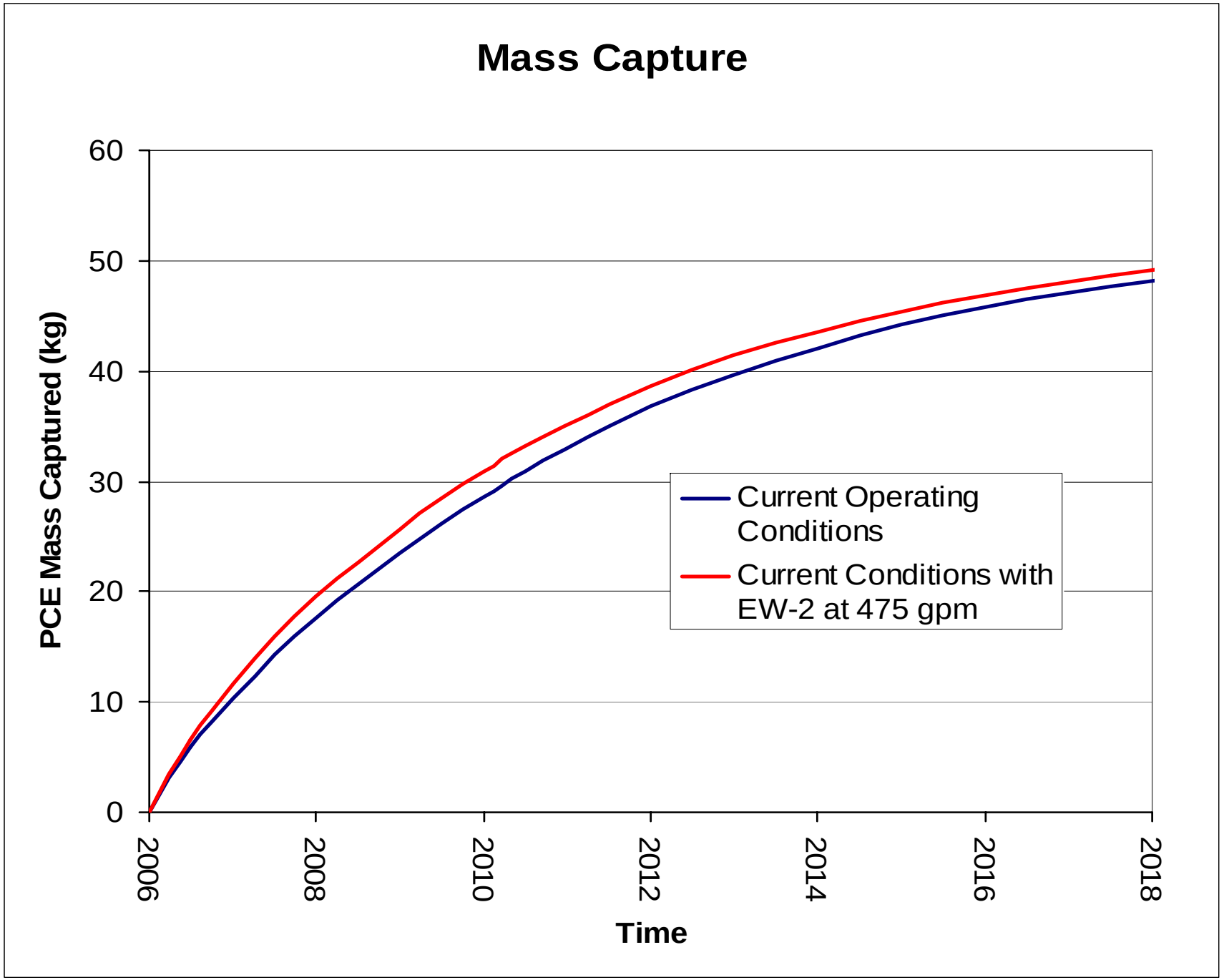


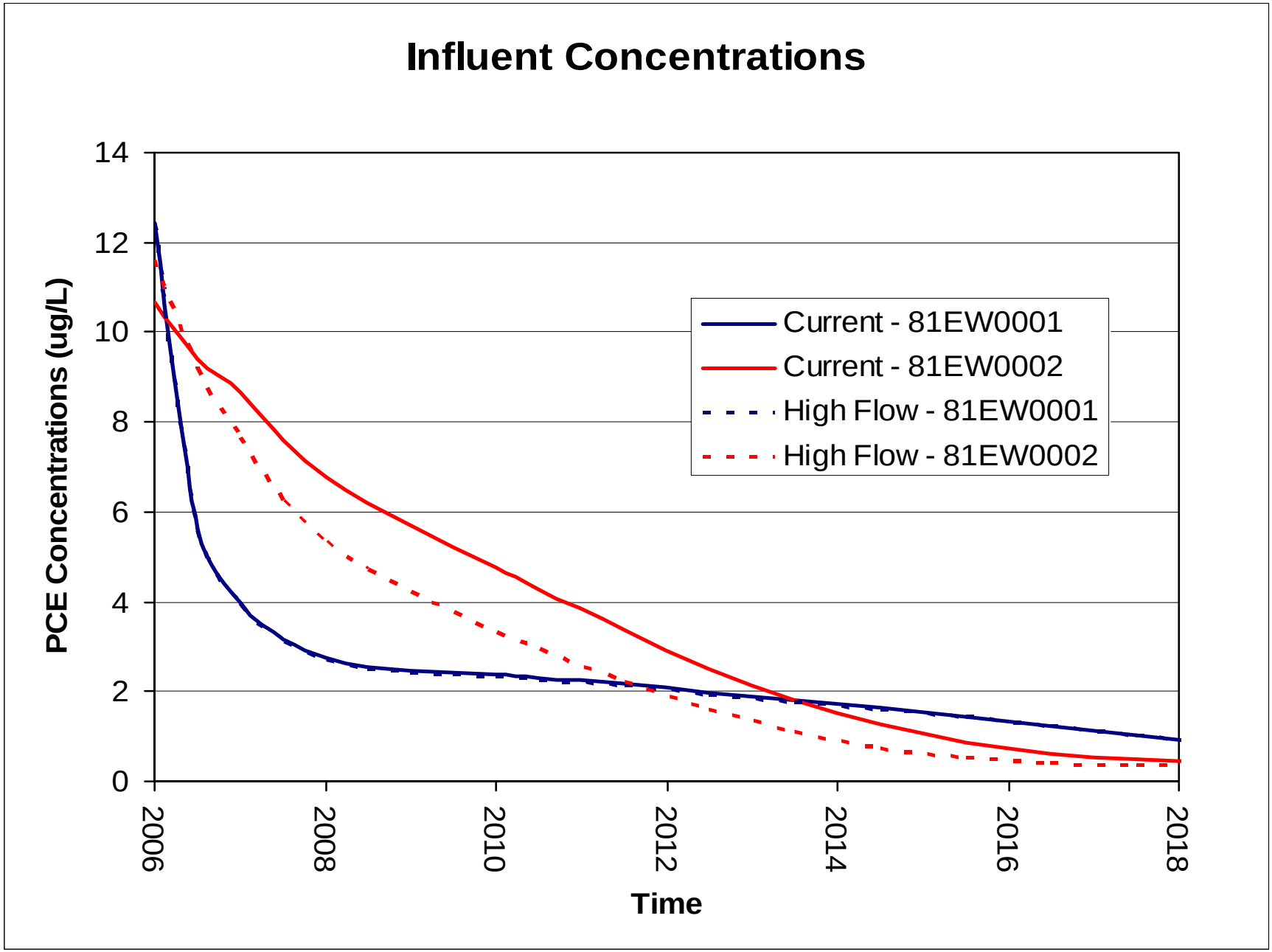
- BACKPOCKET

CS-20 Wellfield Comparison

	Total Mass at Startup (kg)	Mass Above MCL at Startup (kg)	Volume of Plume above MCL at Startup (cubic feet)	Well Clean Year	Plume Clean Year	Total Mass Captured by Well Clean Year (kg)	Percentage of Total Mass Captured by Well Clean Year
As-Built Conditions	72	63	1.40E+08	2017	2024	46	64%
As-Built Conditions with 475 gpm at 81EW0002	72	63	1.40E+08	2017	2022	48	67%
As-Built Conditions with Goletta Well	72	63	1.40E+08	2017	2022	57	80%


32MW2002, 3
81DP1005
81DP1004
81DP1003
81EW0002
81MW0015A
81DP1002
69MW1424
81MW0016A
81DP1006
81DP1001
Legend
5.0 - 20.0 µg/L concentration
20.0 - 50.0 µg/L concentration
> 50.0 µg/L concentration
320 gpm Capture Zone
475 gpm Capture Zone
Extraction Well
Monitoring Well or Drivepoint
0
200
Scale in Feet
JACOBS
CS-20 Capture Zones
with 81EW0002 Pumping
at 320 and 475 gpm
Massachusetts Military Reservation
Cape Cod, Massachusetts
05/18/06
CS20_Capt_Zones2.dwg
Figure 1


Mass Capture
PCE Mass Captured (kg)
60
50
40
30
20
10
0
2006
2008
2010
2012
2014
2016
2018
Time
Current Operating Conditions
Current Conditions with EW-2 at 475 gpm


Influent Concentrations
PCE Concentrations (ug/L)
14
12
10
8
6
4
2
0
2006
2008
2010
2012
2014
2016
2018
Time
Current - 81EW0001
Current - 81EW0002
High Flow - 81EW0001
High Flow - 81EW0002

APPENDIX C

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

September 22, 2008

Mr. James T. Owens, III
Office of Site Remediation and Restoration
U.S. Environmental Protection Agency,
Region 1
One Congress Street, Suite 1100
Boston, MA 02114-2023

RE: BOURNE—BWSC-4-0037
Massachusetts Military Reservation,
Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-29, Fuel Spill-28, and Fuel Spill-13 Groundwater Plumes, Concurrence

Dear Mr. Owens:

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the document entitled **"Final Explanation of Significant Differences for Chemical Spill-4, Chemical Spill-20, Chemical Spill-21, Fuel Spill-29, Fuel Spill-28, and Fuel Spill-13 Groundwater Plumes"** (the ESD), dated August 2008. The ESD was prepared for the Air Force Center for Engineering and the Environment (AFCEE) at the Massachusetts Military Reservation (MMR) by the Jacobs Engineering Group, Inc. in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The U.S. Air Force is the lead agency for CERCLA remedial actions at the MMR.

The ESD documents changes to the selected remedies described in the Final Record of Decisions (RODs) issued for the Chemical Spill-4 (CS-4), Chemical Spill-20 (CS-20), Chemical Spill-21 (CS-21), Fuel Spill-13 (FS-13), Fuel Spill-28 (FS-28) and Fuel Spill-29 (FS-29) groundwater plumes in Falmouth, MA. The two RODs amended by the ESD are the *Final Record of Decision for the CS-4, CS-20, CS-21 and FS-13 Plumes* dated February 2000 and the *Final Record of Decision for the Fuel Spill-28 and Fuel Spill-29 Plumes* dated October 2000. MassDEP concurs with the changes to the remedies selected for the Southwest Operable Unit groundwater plumes (CS-4, CS-20, CS-21, FS-13, FS-28, FS-29), as described in the ESD.

The primary Contaminants of Concern (COCs) in the CS-4, CS-20 and CS-21 plumes are tetrachloroethylene (PCE) and trichloroethylene (TCE). Ethylene dibromide (EDB) is the COC for the FS-28 plume and carbon tetrachloride (CCl_4) and EDB are the COCs for the FS-29

plume. The COCs for the FS-13 plume are 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene. All of the Southwest Operable Unit groundwater plumes are currently undergoing remediation with active treatment systems with the exception of FS-13. Long-Term Monitoring was selected as the remedy for the FS-13 groundwater plume because the COCs are not mobile and have not migrated from a small, localized area of groundwater contamination located on the MMR.

The significant difference between the plume cleanup strategies outlined in the RODs and the current remedial design is that the RODs indicated that all of the groundwater within the CS-4, CS-20 and FS-29 plumes with COCs in excess of federal and state Maximum Contaminant Levels (MCLs) for drinking water would be captured and treated by Extraction, Treatment and Reinjection systems, whereas, the current remedial designs allow for low COC concentrations at the leading edges of the CS-4, CS-20 and FS-29 plumes to reach cleanup levels by the natural attenuation processes of degradation, dilution and dispersion. Specifically, the decision to modify the remedial strategies for the CS-4 and FS-29 plumes is based upon the lack of significant contaminant mass in the leading edges of these plumes. The decision to modify the remedial strategy for the CS-20 plume is based upon access issues for the installation of an extraction well at the leading edge of this plume. Two other minor differences from the RODs include changes in the decision process for determining when the treatment systems may be turned off for the five plumes undergoing active treatment (CS-4, CS-20, FS-28 and FS-29) and changes in the Land Use Controls for all six plumes.

MassDEP concurs with the ESD, based upon representations made to MassDEP by 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, or if conditions within the CS-4, CS-20, CS-21, FS-13, FS-28 and FS-29 groundwater plumes 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 CS-4, CS-20, CS-21, FS-13, FS-28 and FS-29 groundwater plumes. If you have any questions regarding this matter, please contact Leonard J. Pinaud, Chief of 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, Department of Environmental Protection

LB/P/xx
MassDEP SWOU ESD Concurrence Letter.doc

Cc: DEP - SERO

Attn: David Johnston, Acting Regional Director
Millie Garcia-Serrano, Deputy Regional Director
Leonard J. Pinaud, Chief, Federal Facilities Remediation Section
Rebecca Tobin, Regional Counsel

Distributions: SERO
SMB
MMR Cleanup Team
Boards of Selectmen
Boards of Health
Mark Begley, Environmental Management Commission