Final
Demonstration of a Remedial Action Operating Properly and Successfully, AOC 50, Devens, Massachusetts

Prepared For

G/FPR Remediation AOC 50
Devens, Massachusetts
GSA Contract No. GS-10F-0266K
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March 2007

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Infrastructure, environment, facilities

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Transmittal Letter

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Copies:
Mr Mike Daly
Ms Lynne Welsh
Ms Libby Herland
Mr Ron Ostrowski

From:
Chuck Castelluccio

Date:
03/02/07

Subject:
Demonstration of Remedial Action Operating Properly and Successfully. AOC 50 Devens MA

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MA000664

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Our ref:
MA000664

Subject:
Draft Demonstration of a Remedial Action Operating Properly and Successfully, AOC 50, Devens, Massachusetts, December 2006

Dear Ms. Liang:

ARCADIS U.S., Inc. (ARCADIS) on behalf of the U.S. Army has the following responses to the Massachusetts Department of Environmental Protection (MADEP) comments on the subject report. The MADEP comments from January 31, 2007 are numbered below as they were in the comment letter and the ARCADIS responses follow the comments.

1. Several monitoring wells have indicated increasing trends in PCE concentrations: G6M-02-01X increased from 24 to 1300 ppb and G6M-04-03X from 440 to 2600 ppb at Area 2 within two years, G6M-02-05X 130 to 350 ppb at Area 5 within two years. This highlights a concern identified during the FS in which plume bulging was evaluated and determined not to be a problem. Is it possible that bulging is occurring? MassDEP recommends additional monitoring wells in critical locations to evaluate this concern. In addition, G6M-02-03X at Area 2 that serves as a plume perimeter-monitoring well seems no longer valid due to final delineation around G6M-02-01X. Additional monitoring is needed here, as well.

ARCADIS Response

Well G6M-02-01X is located on the edge of the plume outside the area of influence of the Area 2 injection wells, and therefore fluctuations in concentrations in this well are likely not a result of injection activities. Rather, the increase in PCE from 24 to 1,300 ppb may reflect natural plume changes. If increasing trends continue in wells outside the area of influence of the injections, it is not a result of molasses injection activities. Data from the transducer study in 2004 indicated that the small injection volumes used would not significantly change the aerial extent of the plume. If monitoring data

indicate continued increasing trends, then the remedy can be expanded to address this area, i.e. additional injection well can be installed along the existing Area 2 injection well transect should increasing trends in G6M-02-01X continue.

Contaminant fluctuations within the center of the plume, such as in well G6M-04-03X, are also not a result of molasses injection activities due to the large distance between the monitoring well and the nearest injection wells. G6M-04-03X is located approximately 200 ft downgradient of the injection transect in Area 2, corresponding to approximately 800 days of travel time. Since there have only been approximately 730 days since injections began, we would not expect to see a reflection of PCE treatment at G6M-04-03X to date. Again, the trends in G6M-04-03X are more likely a result of natural plume changes. The increase in PCE from 130 to 350 ppb in G6M-02-05X, located in Area 5, is not considered a significant change. Ongoing monitoring will be performed to evaluate long term trends in these wells as the remedy continues.

We agree that well G6M-02-03X is no longer needed as a perimeter monitoring well and should be removed from the long-term monitoring program.

2. The PCE influent concentrations are still very high (about 200 ppb), especially at IWS-2 after more than 2-yrs of IWS system operation that has achieved about 30-lb PCE removal. Additional monitoring wells, northwest of IWS-2, are needed.

ARCADIS Response

Influent PCE concentrations at IWS-2 will not change until the concentrations upgradient of the IWS wells begin to drop as a result of the ERD remedy. In other words, the influent PCE concentrations at IWS-2 are not a reflection of treatment by the IWS system, but rather are a reflection of groundwater quality in the portion of the plume upgradient of the IWS system, which is influenced by IRZ treatment upgradient as well as natural plume changes.

IWS system performance is evaluated by the total mass recovered by the IWS system and decreasing PCE concentrations downgradient of the IWS wells. To date, the system has removed approximately 30 lb of PCE from the groundwater, and data from downgradient wells G6M-04-06X and G6M-04-07X

show declining PCE concentrations. These results indicate that the IWS system is successfully meeting its Remedial Action Objective to provide a polishing step at the downgradient end of the plume to reduce the potential for CVOC and arsenic migration to the river.

Regarding the need for additional wells northwest of IWS-2, a series of Microwells were installed (in 2000) to define the plume boundary in this area (XSA-00-88X, -89X, -and -90X). These wells indicated that PCE concentrations northwest of the existing IWS wells were relatively low (from non-detect in most wells/intervals to 39 ug/L at one depth interval at one location). In addition, performance data collected at upgradient sentinel wells G6M-03-08X, G6M-03-09X, G6M-03-10X, and G6M-04-05X support the vertical and horizontal PCE delineation upgradient of the IWS system. It is ARCADIS' position that the plume boundary northwest of IWS-2 has been adequately delineated and that the existing monitoring well network is sufficient to adequately monitor the plume boundaries and the effectiveness of the IWS system.

3. Monitoring Wells G6M-03-04X and G6M-03-01X have not been included in LTM network. Since high PCE concentrations were detected historically MassDEP would like to request they be sampled once every three years, starting with the next sampling round.

ARCADIS Response

The Army is agreeable to sampling Wells G6M-03-04X and G6M-03-01X once every three years, but since they were last sampled in May 2006, we would recommend sampling them beginning in September 2007 and every three years thereafter.

4. The sampling results from G6M-94-18X provided little support of IRZ establishment at the Drum Storage Area, few daughter products, low TOC concentration and positive ORP. Additionally, data from G6M-04-10A showed some daughter products, but far less than the 35 μM/L of PCE concentration recorded June 2006. Additional monitoring in this location is needed to determine that the ERD is working.

ARCADIS Response

Historical data collected from well G6M-94-18X indicate that although PCE concentrations have been high at this location, these concentrations have been steadily declining since March 2005 (6 events). The lack of daughter products and TOC concentrations at this well suggest that the observed PCE decline is most likely attributed to groundwater flushing and physical attenuation local to this well.

Based on the location of G6M-04-10A, it is more likely that fluctuations in PCE are a result of the molasses injection activities. While a complete mass balance between PCE and degradation products is not observed, it is rare to observe this in field systems. Although natural hydraulic fluctuations will always occur, the decline in PCE at G6M-04-10A is consistent with increased TOC and production of cis-DCE at this location. Also, the declines in nitrate and sulfate and increases in ferrous iron, sulfide, and methane indicate a shift to strongly reducing (methanogenic) conditions at this well. At the same time, production of end product ethene (even at low concentrations) indicates that complete dechlorination is occurring.

At this point we recommend continued monitoring at existing wells within the area to verify current data trends and document the ongoing degradation activity. Based on new data from these wells, it will be determined whether evaluation of additional injection wells is necessary at some point in the future to accelerate the degradation process; however, the current monitoring network in this area is adequate.

As observed in Area 5, CVOC concentrations downgradient of injection wells have fluctuated periodically since injection activities began. Because of these fluctuations, it is difficult to assess IRZ progress on a quarterly basis. Rather, long-term trends are more indicative of overall remedial progress. Operational parameters (TOC and pH) are used on a more frequent basis to support IRZ operations, while less frequent performance monitoring data are used to evaluate long-term trends. Well G6M-04-10A has only recently (June 2006) shown release of adsorbed mass (significant increase in PCE) due to the molasses injection activities, indicating that the ERD process is still continuing to develop. It is ARCADIS' position that the existing monitoring wells are adequate to monitor the ongoing development of the IRZ in this area.

5. Please evaluate the decreased concentrations in G6M-04-09X and G6M-04-31X, which are about 100-ft downgradient of wells G6M-94-18X and G6M-04-10A. The PCE concentration decreased in G6M-04-09X from 7400 ppb to 190 ppb without any daughter products, and G6M-04-31X from 1900 ppb to 600 ppb.

ARCADIS Response

Due to the observed length of the plume, the remedy at wells between the IRZ areas is physical attenuation via clean water flushing and dilution of the plume. Therefore, decreasing PCE concentrations in the absence of daughter products at these locations between the IRZ areas is expected and is a very positive trend. For example, wells G6M-04-09X and G6M-04-31X are outside the direct influence of the IRZ, and decreasing trends are a reflection of treatment upgradient. Based on the data available at this time, the trends in these wells are consistent with what would be expected downgradient of an IRZ in the early stages of development. ARCADIS recommends continued monitoring of these downgradient locations as the IRZs in the Former Drum Storage Area (FDSA) and Former Drywell (FDW) areas continue to develop. Due to the relatively slow groundwater flow in the source areas, ARCADIS feels that annual sampling is appropriate to monitor these changes.

6. HRC injection in June 2000 may have promoted faster IRZ establishment and supplemented the ERD. It should be taken into consideration in the estimation of degradation rates of ERD remediation.

ARCADIS Response

The initial HRC injection in 2000 may have decreased the microbial acclimation timeframes for carbon utilization, but would not have enhanced the rates of degradation presented in the report. Area 5 pilot study data were used to estimate the initial degradation rates based on a flow path analysis of data collected during a single sampling period, conducted almost two years after HRC injection. In other words, data collected following HRC delivery were not used in the rate calculations and therefore do not impact the results. These calculated rate values were then applied in the model to estimate overall site clean-up times. Similar analyses were conducted on Area 5 data from 2004 and 2006, as reported in the September 2006 OPS Report. Again, rates

calculated for these subsequent events do not include data from the period of time around the HRC delivery and thus are not reflective of any impacts attributable to the HRC.

As presented in the OPS Report, the rate of degradation in Area 5 is currently faster than initially calculated, which is consistent with ongoing development of the IRZ. Therefore, the original degradation rate used in the model was a conservative estimate of the necessary remedial time period.

Similar analyses were completed with the data from the other ERD areas (documented in the OPS report), but the variable CVOC concentrations and travel times in the early stages of IRZ development make it difficult to apply a general site-wide degradation rate downgradient of all injection transects. Due to the fact that the other areas are still in the early stages of IRZ development, qualitative ERD trends at the IRZ areas were compared to historical data from Area 5 as described in the OPS report. Long-term performance monitoring data will be necessary to calculate and refine a site-wide rate estimate.

7. With full-scale implementation of molasses injection for 2-yrs and based on the data from Area 5, additional data analysis in other areas should provide more site-specific biodegradation estimates to use to extrapolate for the whole site.

ARCADIS Response

See Response #6. As the ERD operation and monitoring periods continue, more monitoring data will be available for calculation of degradation estimates for each of the individual IRZ transects.

8. Dissolved oxygen saturation through IWS seems not effective at the deeper zone, which is more impacted by PCE. MassDEP is requesting that there be an evaluation for addressing this deeper zone with additional IWS.

ARCADIS Response

The primary goal of the IWS system is to capture and treat impacted water. Groundwater is captured via extraction from the lower zone, and is sparged as it moves up the casing to the upper zone, stripping VOCs from the water

column and increasing the dissolved oxygen content. This oxygenated groundwater is then discharged into the upper zone. Dissolved oxygen levels up to 10 mg/L are observed in the shallow zone. Dissolved oxygen is therefore not delivered directly to the deeper zone since the re-injection of sparged water occurs in the upper zone (as described above). However, elevated dissolved oxygen levels (up to 5.5 mg/L) are observed in the deeper zone of the aquifer due to recirculation from the shallow zone. These data indicate that the IWS system is functioning effectively.

The delivery of oxygen as a by-product of the stripping treatment has no effect on PCE concentrations in groundwater outside of the well (water must enter the IWS well in order to remove PCE via stripping), but forms an aerobic buffer to prevent the flux of reduced metals and TOC downgradient.

9. The pH at G6M-04-06X is about 9 and elevated arsenic concentrations have been detected historically. An increase in the pH to an alkaline condition will cause both arsenite and arsenate to desorb.

ARCADIS Response

Operation of the IWS cannot generate high pH levels in groundwater. Also, high pH is only present at G6M-04-06X, and all other wells in Area 5 have normal pH. It is more likely that the high pH is a result of grout from well installation activities. Both the decreasing trend in pH values since September 2004 and the normal pH values observed in the adjacent monitoring well support this argument. Because elevated pH is only present in one well, any elevated arsenic will be localized to the area around this well. Additional discussion regarding site-wide arsenic behavior was presented in Section 4.4 of the OPS Report.

10. G6M-02-11X may be sampled quarterly instead of annually to ensure ERD zone doesn't go beyond the established reducing zone in Area 5.

ARCADIS Response

Low levels are arsenic have been detected sporadically in Well G6M-02-11X as it appears to be near the downgradient edge of the IRZ. However, since the ERD injections have been on-going in this area since December 2001 (greater

than 1,825 days) and the groundwater travel time from the injection wells to Well G6M-02-11X is approximately 200 days, we feel that the sampling frequency is adequate for its intended purpose. Furthermore, the Sentinel Wells downgradient of this location are being sampled quarterly to detect the migration of arsenic and trigger the contingency remedy in this area, if necessary.

11. Comments from MassDEP legal group about Land Use Control are forthcoming.

ARCADIS Response

ARCADIS will address comments from the MADEP legal group when they become available.

Sincerely,

ARCADIS U.S., Inc.

Charles Castelluccio
Principal Scientist

Copies:
Robert Simeone, U. S. Army
Lynne Welsh, MADEP
Mike Daly, USEPA
Ron Ostrowski, MassDevelopment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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BOSTON, MASSACHUSETTS 02114-2023

March 26, 2007

Mr. Robert J. Simeone
BRAC Environmental Office
30 Quebec Street, Box 100
Devens, MA 01432

Re: **U.S. Army Demonstration that AOC 50 Remedial Actions are Operating Properly and Successfully under CERCLA §120(h)(3)(B), Former Fort Devens, MA**

Dear Mr. Simeone:

Your letter, dated March 21, 2007, conveyed the U.S. Army (Army) determination that the Area of Concern (AOC) 50 remedy at the former Fort Devens, Massachusetts is in place and operating properly and successfully. Transmitted along with your letter was the technical demonstration document that contained the objective data and the weight of evidence used to support the Army determination and demonstrate to EPA that the AOC 50 remedy is operating properly and successfully (AOC 50 OPS Demonstration). Based on our evaluation of the AOC 50 OPS Demonstration and consultation with the Massachusetts Department of Environmental Protection (MassDEP), EPA-New England hereby approves of the Army demonstration that the AOC 50 remedy is in place and functioning in a manner that is expected to adequately protect human health and the environment when the remedial actions are completed. The specific aspects of evaluating whether a remedial action is operating properly and successfully and when to approve a federal agency demonstration have been delegated to EPA-New England.

The determination that a remedy is operating properly and successfully is a precondition to the deed transfer of federally owned property in accordance with Section 120(h)(3) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C §9620(h)(3). A federal agency can transfer real property subject to Section 120(h)(3) by deed once a remedial action has been constructed and installed but before the cleanup objectives have been met, provided that the federal agency can demonstrate to EPA that the remedial action is operating properly and successfully.

EPA-New England's approval of the AOC 50 OPS Demonstration is made without any independent investigation or verification of the information used to support the AOC 50 OPS Demonstration. EPA-New England expressly reserves all rights and authorities relating to information not contained in the AOC 50 OPS Demonstration, whether or not such information is known as of this date or discovered in the future. Further, EPA-New England's approval of the AOC 50 OPS Demonstration is solely for the purpose of allowing deeded transfer of property and does not imply that all cleanup actions are completed. The Army is still obligated to complete remedial actions for AOC 50 as specified in the January 2004 AOC 50 Record of Decision. EPA-New England and MassDEP will continue its involvement and oversight of the Army's environmental restoration of AOC 50 and other identified sites at the former Fort Devens, as required by the Fort Devens Federal Facility Agreement dated May 1991.

EPA-New England would like to congratulate the Army for preparing a detailed, high-quality OPS demonstration that meets the intent of EPA's interim guidance for OPS demonstrations. This OPS Demonstration will allow the 4.3 acres of Army property to be deeded to MassDevelopment. As always, we look forward to working with you, MassDEP and MassDevelopment in continuing the environmental cleanup and economic redevelopment successes at Devens.

Sincerely,

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

cc: Ron Ostrowski, MassDevelopment
Lynne Welsh, MassDEP
Hui Liang, MassDEP
Bryan Olson, EPA-NE
Ginny Lombardo, EPA-NE
Mike Daly, EPA-NE

FINAL-Demonstration of a Remedial Action Operating Properly and Successfully, AOC 50, Devens, Massachusetts

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Prepared for:

G/FPR Remediation of AOC 50, Devens, Massachusetts
GSA Contract No. GS-10F-0266K
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Date:

March 2007

Table of Contents

TABLES

FIGURES

APPENDICES

ACRONYMS

AOC	Area of Contamination
ARAR	applicable or relevant and appropriate requirement
BCT	Base Cleanup Team
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cis-1,2 DCE	cis 1,2-dichloroethene
COC	chemical of concern
CVOC	chlorinated volatile organic compound
cy	cubic yard(s)
DEC	Devens Enterprise Commission
DNAPL	Dense Non-Aqueous Phase Liquid
EPA	Environmental Protection Agency
ERD	Enhanced Reductive Dechlorination
FDSA	Former Drum Storage Area
FDW	Former Drywell Area
FOST	Findings of Suitability
FS	Feasibility Study
ft	feet or foot
gpm	gallons per minute
HRC	Hydrogen Release Compound
IC	Institutional Control
IRZ	*In-situ* Reactive Zones
IWS	In-well Stripping
LTMP	Long Term Monitoring Plan
LUC	Land Use Control
MAAF	Moore Army Airfield
MADEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
mi	Mile
MOA	Memorandum of Agreement
NGVD	National Geodetic Vertical Datum
O&M	Operation and Maintenance
OPS	Operating Properly and Successfully
PCE	tetrachloroethene
pH	negative log of the hydrogen ion concentration
PID	photoionization detector
ppb	parts per billion
RAO	Remedial Action Objective

RAWP	Remedial Action Work Plan
RD	Remedial Design
RFTA	Reserve Forces Training Area
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RQD	Rock Quality Designation
SI	Site Investigation
SVE	soil vapor extraction
TCE	trichloroethene
TOC	total organic carbon
TVOC	total volatile organic compounds
USCS	unified soil classification system
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound
WWTP	waste water treatment plant

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to document that remedial actions are "Operating Properly and Successfully" (OPS) for Area of Contamination 50 (AOC 50) at the Devens Reserve Forces Training Area (RFTA), Devens, Massachusetts. This OPS document is a precondition to the deed transfer of federally-owned property, as required in Section 120(h)(3) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A successful OPS demonstration to the United States Environmental Protection Agency (USEPA) allows for the deeded transfer of property undergoing long-term remedial actions prior to the attainment of all environmental cleanup objectives. Demonstration of OPS is one facet of the deed transfer process for federally-owned property.

AOC 50 (Site) is located on the northeastern boundary of the former Moore Army Airfield (MAAF), within the former North Post portion of the Devens RFTA, Devens, Massachusetts (**Figure 1**). The AOC 50 Source Area comprises less than 2 acres and surrounds Buildings 3803 (the former parachute shop), 3840 (the former parachute shakeout tower), 3824 (a gazebo), and 3801 (the former 10th Special Forces airplane parachute simulation building). Sources of groundwater contamination within AOC 50 include a drywell formerly connected to the parachute shakeout tower and the tetrachloroethene (PCE) drum storage area; these sources are collectively referred to as the Source Area (**Figure 2**). Although these sources have been removed or taken out of commission, groundwater underlying AOC 50 contains elevated concentrations of volatile organic compounds (VOCs), most notably PCE. The primary area of groundwater contamination at AOC 50 is referred to as the Southwest Plume, which extends from the Source Area approximately 3,000 feet downgradient to the Nashua River.

The approved remedy for AOC 50 includes soil vapor extraction (SVE) in the Source Area, an In-Well Stripping (IWS) system at the downgradient end of the Southwest Plume and in-situ treatment of the remainder of the Southwest Plume using enhanced reductive dechlorination (ERD) technology coupled with groundwater monitoring and institutional controls. Contingency remedies have also been reserved for both the North Plume (oxidation) and the downgradient end of the ERD treatment area across the Southwest Plume (iron addition for inorganics mobilization).

1.2 OPS Definition

The USEPA guidance document on OPS (USEPA 1996) defines operating properly and successfully as two separate concepts. A remedial action is operating "properly" if it is operating as designed. That same system is operating "successfully" when its operation indicates it can achieve the cleanup levels or performance goals delineated in the decision document, and the remedy is protective of human health and the environment. The USEPA guidance document on OPS thus interprets the term "operating properly and successfully" to mean that the remedial action is functioning in such a manner that it is expected to adequately protect human health and the environment when completed.

1.3 Applicability

Demonstration of operating properly and successfully is made to the USEPA Administrator and is applicable when a federal agency is implementing an ongoing remedial action and desires to transfer the property before the remedial objectives are met.

This OPS document for AOC 50 will be used as part of the transfer documents for Parcel A5 shown on **Figure 3**. A complete description of the A5 parcel can be found in **Appendix A**. CERCLA, Section 120(h)(3) requires that deeds which transfer federally-owned property where hazardous substances were known to have been stored, released, or disposed of, shall contain a covenant warranting that "all remedial action necessary to protect human health and the environment with respect to any [hazardous] substance remaining on the property has been taken before the date of such transfer." CERCLA, Section 120(h)(3) was amended in October 1992 to add language stating that all such action has been taken "if the construction and installation of an approved remedial design has been completed and the remedy demonstrated to the [USEPA] Administrator to be operating properly and successfully."

The U.S. Army, upon compliance with the requirements of Section 120 of CERCLA, transferred various parcels at the Devens RFTA to Massachusetts (Mass) Development and the US Fish and Wildlife Service. The deeded property included Parcels 4 and 1e but excluded the property identified as Parcel H (active RFTA) and Parcel A5 on **Figure 3** of this OPS document. Upon demonstration of the remedial actions established in the Record of Decision (ARCADIS 2004a) to be operating properly and successfully, the excluded Parcel A5 will be transferred to Mass Development by quitclaim deed. This OPS document addresses only the actions taken at AOC 50.

2.0 SITE CHARACTERIZATION

2.1 Source Areas

Sources of contamination within AOC 50 include a former drywell and the former PCE drum storage area. These sources are briefly discussed below.

2.1.1 Drywell

In 1969, Building 3840 was constructed and attached, via an enclosed walkway, to Building 3803. In addition, two large sinks and a janitors' room were added to Building 3803. The design drawings for Building 3840 indicate that a floor drain was constructed in the center of the concrete floor. This floor drain, the additional sinks in Building 3803, and the roof drains for Building 3840 were piped to a drywell located approximately 20 ft northeast of Building 3840 (**Figure 2**). The concrete drywell was approximately 5 ft in diameter and 8 ft deep, with an open bottom and a cover on the top. This drywell received wash water, rainwater, and PCE waste associated with parachute cleaning activities.

The drywell near Building 3840 and associated piping were removed for the Army by Roy F. Weston Corporation between November and December 1996 (Weston 1997). The resulting excavation was approximately 9.5-ft deep and covered an area approximately 21 feet (ft) by 30 ft, equating to approximately 225 cubic yards (cy) of soil (in-place). In addition, sanitary waste from Building 3803 was collected in a 10-foot diameter, 9-foot deep cesspool. This cesspool was removed concurrent with the drywell associated with Building 3840. During the cesspool removal activities, a total of 25 CY of soil, sludge, and concrete were excavated and taken offsite for treatment and disposal. Details regarding the removal activities are documented in a September 1997 report titled *Removal Action Report; Dry Well, Cesspool, and Fuel Oil Underground Storage Tank (UST); Area of Contamination (AOC) 50, Moore Army Air Field, Devens, MA* (Weston, 1997).

In addition to the removal of the drywell and cesspool, a 750-gallon fuel storage UST associated with the Building 3840 heating system was also removed. In connection with the tank removal, approximately 787 gallons of oil, water, and residual sludge were recovered from the tank and approximately 25 cy of contaminated soil were excavated. Solid and liquid wastes generated during removal of the drywell and fuel storage UST were taken off-site for proper treatment and disposal.

2.1.2 Tetrachloroethene Drum Storage Area

A PCE drum storage area east of Building 3801 was identified during field investigation activities completed in 1992. Historical records and interviews with former Fort Devens personnel indicate this area was used to store single drum quantities of PCE (HLA, 2000a). The PCE was used by Army personnel in Buildings 3803 and 3840 for spot cleaning of parachutes. Parachute cleaning was performed only as needed to maintain the integrity of the parachute material. Unused PCE was either reused or may have been washed down into the drywell system associated with Buildings 3803 and 3840. This information was supported by a review of the historic hazardous waste manifests, which did not include the removal of waste chlorinated solvents from AOC 50 (Mott, 1997). The use of this area for drum storage was discontinued in 1992. The length of time or total number of drums stored in this area of AOC 50 is unknown.

Based on the results of various field investigations, PCE was detected in vadose zone soils beneath the former drum storage area and was likely contributing to PCE impacts in groundwater. An interim removal action for PCE-contaminated soil at the former drum storage area was planned and implemented as a source-control measure while additional investigation activities were conducted across the site. An *in-situ* soil vapor extraction (SVE) system was installed adjacent to the former drum storage area in December 1993 and January 1994. Five soil vapor extraction wells (SVE-1 through SVE-5) were installed, one in the center of the presumed PCE source and four on the periphery (**Figure 2**).

Operation of the SVE system began in February 1994 and continued through July 1996. Operation & Maintenance (O&M) data collected between February 1994 and July 1996 indicated that approximately 240 pounds (approximately 18 gallons) of PCE were successfully recovered in the vapor phase. Details regarding the installation, operation, and performance of the SVE system between February 1994 and July 1996 are documented in a November 1996 report titled *Summary Report, SVE Monitoring, AOC 50* (ABB, 1996a).

The SVE system was operated again for brief periods in December 1998, May and June 1999, and October and November 1999. The brief periods of SVE system operation after the 1996 shut down were conducted to evaluate the concentration of PCE in the soil vapor, under equilibrium conditions. In general, recovered vapor concentrations were either below the detection limits of a photoionization detector (PID), or after a brief peak observed when the system was restarted, quickly attenuated within minutes. No appreciable mass of PCE was recovered during the brief periods of SVE operation between 1998 and 1999. ARCADIS reactivated the SVE system in September 2004 with the addition of one new extraction well to address sorbed PCE in vadose zone soils in the former Drum Storage Area. Based on low mass removal rates the system was shut-down permanently in November 2005.

2.2 Site Characterization

A variety of contractors have completed site work and investigation at this facility and the AOC 50 area. The salient conclusions from these various investigations are summarized in the following sections.

2.2.1 Geology

The lithology beneath AOC 50 and the former MAAF can be subdivided into three principal geologic units: bedrock, till, and unconsolidated glacio-fluvial deposits. The unconsolidated sediments are variable in thickness and are draped across metamorphic bedrock, which tends to be massive and extensive. Each of these units is described in more detail in the following subsections.

The bedrock has been described as being consistent with that of the Oakdale formation. The Oakdale formation is a siltstone that has been altered to a meta-siltstone to phyllite grade metamorphic rock. The competency of the rock, as measured by Rock-Quality Designation (RQD) calculations, is very good and increases with depth. The shallow bedrock was fractured and subsequently filled and re-cemented with calcite and other precipitates.

Bedrock reaches its lowest elevation within a bowl shaped depression below the runways of the former MAAF. In this area, bedrock elevations dip to 60 feet NGVD. Depth to bedrock at the site ranges from approximately 60 feet bgs (near Building 3840) to approximately 200 feet bgs (at the western end of the former MAAF).

Samples collected at the overburden/bedrock interface at some locations have been categorized as ice contact deposits (till). Till differs from other glacial deposits in that it is subglacial in origin and transported from its place of origin by glacial ice. Due to the weight of the overlying ice, subglacial deposits can be very dense and have low permeability. The thickest deposit of till is approximately 19 feet at G6M-97-28X but is typically less than 5 feet. The occurrence or absence of till appears to correlate to the elevation and topography of the bedrock. The till is absent or very thin above topographic bedrock highs, while deposits are generally thick in depressions and at lower bedrock elevations.

The geologic deposits overlying the bedrock and till have been classified as glacio-fluvial sediments. Lacustrine deposits, outwash plains, and deltaic deposits are collectively referred to as glacio-fluvial deposits. The fluvial deposits that were laid upon, within, or laterally in contact with glacial ice are referred to as kame deposits. Because the fluvial sediments were deposited by moving water, the finer sediments have been preferentially sorted out. As the ice retreated, these deposits were left behind as elevated plains or terraces within the river valley. These deposits rise above the surrounding topography and form flat plains at approximately 265 feet NGVD. The thickest kame deposit is approximately 200 feet (below the former MAAF where the bedrock elevation drops to 60 feet NGVD).

Northeast of the former MAAF, towards AOC 50, the ground surface elevation drops quickly to approximately 225 feet NGVD. This change in elevation represents a change in the depositional origin of sediments. Ground penetrating radar returns and exposures within excavations have documented inclined bedding planes within the sediments at AOC 50 and to the north. These features, in conjunction with the ground surface elevation change, have been interpreted as indicating the sediments of AOC 50 were laid down within a deltaic environment originating from an ice-dammed lake. These sediments are not as thick as those of the kame and decrease in thickness to the north and west where bedrock rises.

Numerous monitoring wells, Microwells™, and boreholes have been installed at the former MAAF and AOC 50 to characterize the groundwater conditions. The following section describes the hydro geologic environment based on a review of the data presented within the RI report (HLA, 2000a).

2.2.2 Hydrogeology

A single water table aquifer occurs within the overburden deposits below the former MAAF and AOC 50. Low permeability confining units were not encountered during the previous investigation programs and no confined aquifers have been identified. Restrictions to vertical groundwater flow, such as silty clay layers, are not common in boring logs within the kame deposit or along the Nashua River. However, some silty clay layers were reported to be present within the soils below AOC 50 (Source Area). These thin, silty clay layers reduce the vertical permeability, contribute to a slight increase in the water table elevation, and increase the difference between shallow and deep water levels.

Groundwater is encountered at approximately 10 feet bgs in the AOC 50 Source Area and approximately 65 feet bgs at the western end of the former MAAF. Groundwater elevations within deeper wells at and to the North of AOC 50 typically have lower heads indicating that there is a downward hydraulic gradient within this area.

The Nashua River is the controlling hydrologic feature of AOC 50 and the former MAAF area. As groundwater beneath AOC 50 moves downgradient toward the Nashua River to the southwest, vertical gradients become neutral. Vertical gradients reverse and become upward along the Nashua River, as would be expected near such a discharge feature. These changes in gradient demonstrate that groundwater is recharged near AOC 50, travels below the former MAAF, and discharges into the Nashua River.

2.2.2.1 Groundwater Recharge

Recharge to the aquifer below the former MAAF and AOC 50 occurs predominantly by infiltration of precipitation. Average rainfall within this region is approximately 44 inches per year (in/yr) (National Climatic Data Center, 2002). The recharge rate is based on precipitation minus surface water runoff and evapotranspiration. Basin-wide recharge to the aquifer can be computed from base flow stream discharge within the aquifer basin. By definition, the base flow discharge in a stream equals the rate of groundwater recharge within the local drainage basin.

The aquifer below AOC 50 and the former MAAF discharges to the Nashua River and its tributaries. The Nashua River is a regional discharge point for groundwater and surface water flow and is the dominant hydrological feature within the study area. The Nashua River is approximately 80 to 100 feet in width, 5 to 6 feet in depth, and its surface is at an elevation of approximately 200 feet NGVD within the study area.

2.2.2.2 Groundwater Travel Time

The groundwater travel time from AOC 50 to the Nashua River was computed using hydro geologic data collected at the site. The hydraulic gradient is computed by dividing the difference in water levels between AOC 50 and the Nashua River by the travel distance. The length of this travel path is approximately 2,950 feet. The difference in water levels was calculated using average water level data collected from June 1997 through October 2001. The average water level elevation near the Merrimack Fire Pond is approximately 214 feet NGVD (G6M-96-21A - 213.92 feet, G6M-96-23A - 213.95 feet and G6M-96-24A - 213.54 feet). The elevation of the Nashua River within the discharge area is approximately 200 feet NGVD. The horizontal hydraulic gradient (i) is therefore calculated as follows:

$$i = \frac{dh}{ds} = \frac{change \quad in \quad water \quad level}{distance} = \frac{(214 - 200)}{2,950} = 0.00475 \quad ft / ft$$

Hydraulic conductivity estimates for the aquifer are available from slug tests conducted in the monitoring wells installed in the overburden. These tests estimate the horizontal hydraulic conductivity (K_h) by measuring the time it takes for a displaced water column to return to static levels. Near AOC 50 Source Area, where the soils have a higher silt content, the hydraulic conductivities are lower (approximately 1 to 2 feet per day, [ft/day]). Towards the river and in the western portion of the former MAAF, the hydraulic conductivities increase as the soils become cleaner (less silty) and coarser. Slug tests in this area predict hydraulic conductivity values higher than 50 ft/day. The compacted till and bedrock underlying the sands have the lowest measured hydraulic conductivity values at the site all on the order of less than 3 ft/day or one to two orders of magnitude times less conductive than the overburden materials.

These site-specific conductivity data, with an estimated value of effective porosity, can be used to compute groundwater velocities using Darcy's law. Effective porosity is the measure of that portion of the total porosity in which active circulation or movement of groundwater occurs. The effective porosity was estimated from soil textural classification. The typical effective porosity values for these soil classifications are from 15 to 20%. These values are considered to be appropriate for mixtures of sand and silt at AOC 50 and the former MAAF.

Given an estimate of effective porosity, hydraulic gradient, and hydraulic conductivity, the Darcy seepage velocity can be calculated using the following equation:

$$v = \frac{K \ i}{n_e} \tag{2-1}$$

where:

K = the hydraulic conductivity (approximately 1 to 50 ft/day in the sands)

$n_e = 0.2$

$i = 0.00475$

Substitution of values results in a calculated seepage velocity in the sands ranging from approximately 0.024 to 1.19 ft/day. This range is representative of possible seepage velocities and not the average bulk value for groundwater movement. The average of these two values is approximately 0.60 ft/day.

2.2.3 Nature and Extent of Groundwater Contamination

The recent groundwater analytical data for AOC 50 is presented in **Table 1**, and the iso-concentration contours for PCE in groundwater are shown on **Figures 4 through 7**.

Groundwater data indicates the AOC 50 groundwater plume contains concentrations of PCE, trichloroethene (TCE), 1,2–dichloroethene (1,2-DCE), and vinyl chloride (VC) above their Maximum Contaminant Levels (MCLs). The extent of VOCs in groundwater can generally be delineated by the PCE 5 µg/L contour line as shown on **Figures 4 through** 7. On-going active remediation has lowered these PCE levels and is expected to continue to do so.

2.2.4 Nature and Extent of Soil Contamination

Potential sources of soil contamination within AOC 50 include a drywell and the PCE drum storage area which are located in the Source Area. Subsurface investigations and extensive characterization of the soil contamination in the Source Area have been completed dating back to 1992 with well installation and sampling associated with the initial Site Investigation. Since that time, nine deep soil borings, 14 groundwater screening points (screened auger and Microwell^{TM}), 13 monitoring wells, and three piezometers have been installed. These subsequent investigations were conducted over the course of several years and presented as part of the Supplemental Site Investigation in 1993, Phase III Site Investigation in 1994 and 1995, and the various phases of the RI from 1996 through 1999.

More recent investigations and analyses did not identify any evidence of drainable or residual non-aqueous phase PCE in the Source Area. These conclusions are supported by the documentation presented in the *Supplement Investigation Report*, dated 14 June 2002 (ARCADIS 2002a) and the Final Remedial Action Work Plan (ARCADIS 2005a).

These previous investigations indicate that there were only limited impacts to vadose zone soil in the source area, and the impacted soil was removed during closure activities to prevent further impacts to groundwater. A limited amount of adsorbed phase PCE was apparently present in the vadose zone soils in the former drum storage area and this was targeted for removal with the operation of the SVE system as described in the Remedial Design (ARCADIS, 2004b). The SVE system operated during two different periods to remediate soil in this area, and removed the final mass of PCE and was shut down in November 2005. This was documented in communication between ARCADIS and the USEPA and MADEP confirming that the SVE system had completed remediation in this area. Final remediation of the vadose zone soils in the former drum storage area with SVE remediated the last known area of impacted soil in the Source Area.

2.3 Conceptual Site Model

Based on the site history, geology, hydrogeology, surface water hydrology, and contaminant distribution, a conceptual site model was developed for AOC 50 and is outlined in the following section, and the groundwater modeling report (ARCADIS, 2002b). The original source of chlorinated solvents in groundwater is believed to be the former drywell and former PCE drum storage area. This area is considered the AOC 50 Source Area. The Army discontinued drum storage of PCE in 1992 and removed the drywell (and related soils) in 1996. PCE released from these two areas would migrate vertically through the vadose zone to the aquifer.

PCE has been detected in groundwater (dissolved phase) north of Route 2A (North Plume), and southwest of the Source Area (Southwest Plume). Known activities at the site indicate that limited amounts of PCE were released to the drywell and to the ground surface at storage/handling locations. The releases would be expected to dissipate through dissolution by infiltration to groundwater. Adsorption of aqueous phase contaminants onto soil occurs as a function of equilibrium partitioning as the groundwater plume migrates with the natural groundwater flow direction. The higher silt content of soils in the Source Area provides for higher adsorptive capacity and slower groundwater flow rates in the Source Area.

In addition to partitioning into the aqueous (dissolved) and adsorbed phases, the possibility exists for chlorinated solvents such as PCE to remain in a non-aqueous or free phase depending on a number of factors including the amount and duration of material released and the fraction of organic carbon in the soils. Since free phase chlorinated solvents, including PCE, are typically denser than water, the non-aqueous phase of PCE and other chlorinated solvents are collectively referred to as dense non-aqueous phase liquids (DNAPLs). The presence of a free or DNAPL is important to consider when planning a groundwater remediation program because this phase can present a large percentage of the total contaminant mass (as compared to the dissolved phase) and also presents a source of ongoing dissolved impacts. However, as outlined previously, extensive investigation and analytical testing in the Source Area do not suggest that a DNAPL exists at the site. Numerous soil borings, soil samples, and screening groundwater samples have been collected in the Source Area locations and the concentrations of PCE in these samples are generally lower than would be associated with DNAPL. The length of the PCE plume (over 2,000 feet) and the historic presence of milligram per liter concentrations of PCE in three monitoring wells in the Source Area (G6M-93-14X, G6M-94-18X, and G6M-96-13B) indicate that adsorbed phase PCE is present below the water table in the Source Area.

The distribution of PCE and other VOCs follows the hydraulic gradients at the site. The bulk of the dissolved impacts moves away from the Source Area and migrate with groundwater to the southwest **(Figure 4)**. The downward hydraulic gradients in the Source Area were demonstrated by water elevation measurements in well pairs. Groundwater monitoring data indicate that a minor northward component of flow is present or has been present in the past.

The average groundwater velocity is estimated to be approximately 0.6 ft/day (212 feet per year [ft/yr]). The groundwater flow direction is generally southwest across the site. The contaminant plume has migrated with groundwater southwestward to the Nashua River. Based on the estimated groundwater velocity and a minimum sorption and attenuation for PCE, a maximum of 28 years would be required for the PCE to reach the river. Although the groundwater plume discharges to the Nashua River (based on water level elevation measurements collected in well pairs in this area), the concentrations of contaminants in the river would be significantly lower due to mixing.

3.0 REMEDY SELECTION

On January 2, 2004, the US Army and USEPA, with concurrence from the MADEP, and in accordance with the CERCLA, 42 USC § 9601 *et seq.,* issued the Record of Decision (ROD) for AOC 50 Devens RFTA Site (ARCADIS 2004a). The ROD which was signed in March 2004, focused mainly on selecting in-situ remedies designed to restore groundwater at AOC 50. As documented in the ROD, the following activities were to be implemented at AOC 50:

- Soil Vapor Extraction (SVE) in the Source Area;
- Enhanced Reductive Dechlorination (ERD) throughout the site;
- In-Well Stripping (IWS) along the downgradient portion of the Southwest Plume;
- Contingency for Chemical Oxidation in the North Plume;
- Contingency for evaluation and manipulation of aquifer chemistry for re-precipitation of solubilized inorganics associated with the ERD process;
- Long-term monitoring;
- Institutional Controls; and,
- Five-Year Site Reviews

In accordance with the ROD, the Remedial Design (ARCADIS 2004b) includes four major elements including; ERD, IWS, SVE, and contingency remedies. These are described in detail in the Remedial Design (RD) and summarized in the following sections.

3.1 Enhanced Reductive Dechlorination

Enhanced reductive dechlorination (ERD) is an in situ reactive zone (IRZ) strategy that modifies an aquifer's microbial community to induce dechlorination of solvents and other chlorinated organics. The process relies on the injection of a dilute solution of potable water and a source of degradable organic carbon into the aquifer, to achieve four process goals:

1. Heterotrophic Respiration: This involves overcoming the aquifer's supply of "aerobic" electron acceptors, including oxygen, nitrates, various iron and manganese minerals, and sulfate. There is continuous electron acceptor supply for every contaminated aquifer segment, arriving in groundwater from upgradient, through recharge from above and from the aquifer matrix minerals.

2. Fermentation: This involves generation of intermediate fermentation products such as alcohols and ketones, along with biosurfactants. In conjunction with increased concentration gradients and the increased solubility of degradation intermediates, these fermentation products help to increase the rate of non-aqueous contaminant mass dissolution (sorbed and residual) from the aquifer matrix. This is a critical element of all successful solvent cleanups and is often overlooked in the remedy design process.

3. Hydrogen Generation: Hydrogen is a terminal fermentation product that serves as an electron donor in microbial metabolic dechlorination reactions.

4. Achieve Complete Reductive Dechlorination: The primary degradation pathway supported by the technology is dehalorespiration. Early-stage dechlorinating bacteria use organic carbon or hydrogen as an electron donor and PCE or TCE as an electron acceptor. Late-stage dechlorinating bacteria use hydrogen as an electron donor and cis-DCE or VC as electron acceptors.

In addition to the above, the microbial activity stimulated via ERD technology can support parallel mechanisms for solvent destruction, including abiotic dechlorination through heterogeneous reductive reactions (e.g., reactions with reduced iron minerals) and anaerobic oxidation reactions (many bacteria species can use chlorinated alkenes as electron donors, especially cis-DCE and VC).

The application of ERD to the entire footprint of a large plume is typically impractical. In most cases, source remediation is coupled with a series of downgradient reactive zone barriers oriented perpendicular to groundwater flow. These barriers are configured as treatment transects across the width of the plume and break the plume into smaller sections. This configuration accelerates the attenuation of mass in the area that falls outside the active treatment zones between each transect. This approach was adapted for the source area and southwest plume at AOC 50.

The design presented in the RD is based in part on an updated version of the groundwater flow model presented in the Final Feasibility Study (FS) for AOC 50 (ARCADIS, 2002b) and the empirical results of the long-term pilot test in the ERD Area 5 transect. Based on these results, in addition to data collected from the Area 5 Pilot Test (Figure 7), the ERD technology was implemented across the Site.

It is expected that reagent injection will continue for approximately 10 to 15 years (based on the groundwater modeling results) for successful treatment of the CVOCs by the ERD remedy. Following the ERD application period, the inorganic data collected during the long-term monitoring will also be evaluated to assess that adequate restoration of natural aerobic conditions and re-precipitation of inorganics has been achieved (inorganic compounds are solubilized within the reducing zones created by ERD technology). If warranted, the re-precipitation of inorganics will be expedited through manipulation of groundwater chemistry and/or application of other treatment technologies along the length of the plume utilizing the existing ERD injection wells.

3.2 IWS Well Transect

The AOC 50 remedy includes the installation of an in-well stripping (IWS) system in the downgradient portion of the Southwest Plume, upgradient of the Nashua River. IWS is an innovative variant of conventional air sparging in which a specially designed, two-screened well is employed to remove VOCs from groundwater via the physical removal process of air stripping. Two screened intervals (inlet and recharge screens) are separated by a smaller-diameter inner casing (eductor) and a packer. Compressed air is injected inside a smaller-diameter inner casing, which, when released creates a density driven air lift pump, which forces the groundwater in the well up through the eductor to the top of the well. As the water is drawn up the eductor, the injected air also aerates the groundwater, which strips VOCs from the groundwater and saturates treated groundwater with oxygen. In this application for AOC 50, a small well pump and packer system is used to assist in the pumping process and pump groundwater from the lower screen to the top of the eductor, where the air lift pumping and stripping action takes place.

When the air/water mixture reaches the top of the eductor the mixture is released into the larger diameter outer casing, resulting in a rapid decrease in air and water velocity. This sudden change in velocity causes the mixture to separate, with the air rising to the top of the casing, and the groundwater falling to the bottom of the casing outside the eductor. The separated air is discharged from the well and vented to the surface and the treated groundwater flows back into the aquifer through the upper screened interval (recharge screen).

The inlet (lower) screen interval of the IWS wells are positioned to intercept the zone of highest CVOC concentrations, with the recharge (upper) screen interval positioned at the upper limit of the impacted zone (to prevent potential cross-contamination of unimpacted zones). The lower screen will also intercept the zone of potential reducing conditions where the highest potential for solubilized inorganic compounds exists should this condition present itself. The IWS will create aerobic conditions conducive to the precipitation of solubilized inorganic compounds and the oxidation of daughter products of PCE reduction.

3.3 Application of SVE in the Source Area

The existing SVE system formerly operated in the Source Area at AOC 50 was refurbished for use in the preferred alternative based on the results of the pre-design investigation which is documented in the Remedial Action Work Plan (ARCADIS 2005a). The SVE system applies vacuum to wells completed within the unsaturated soils, capturing VOC mass in the vapor phase as soil gases are withdrawn. The soil gases extracted from the subsurface are treated as needed with activated carbon prior to being discharged to the atmosphere. Operation of the SVE system in the Source Area provides indirect remediation of groundwater impacts if recoverable CVOC mass is present in the unsaturated zone. Specifically, the removal of adsorbed phase mass from vadose zone soil eliminates a potential continuing source for groundwater contamination. One new SVE well (SVE-6) was installed as part of the pre-design investigation and was incorporated into the system during the start-up.

The SVE system was operated for about six months out of a one-year period, operating between September 2004 and November 2005 when soil conditions were relatively dry and sufficient soil vapor could be extracted. Some additional PCE mass was removed with the additional operation, but ARCADIS recommended to the USEPA and the MADEP in correspondence (November, 2005) that the system be shut down due to the limited mass removal and the achievement of appropriate soil standards. The USEPA and MADEP agreed with this assessment, and the SVE system was decommissioned in 2006. As the SVE system is no longer operational, the system performance will not be considered further in this OPS evaluation.

3.4 Contingency Remedies

In addition to the three major elements outlined above, the design includes two contingency remedies outlined in the following sections.

3.4.1 North Plume

The primary method of groundwater remediation for the low levels of CVOCs observed in the North Plume area will be the application of ERD in the AOC 50 Source Area. However, the ROD noted that in the event that PCE or its daughter products exceed their respective maximum contaminant levels (MCLs) in the North Plume one year after ERD implementation in the Source Area, a direct application of *in-situ* chemical oxidation should be utilized to treat the CVOCs in the North Plume.

Continued monitoring of the groundwater in this area indicated that the remedial goals were close to being met through natural attenuation mechanisms and that the trends indicated that this could occur within a two to four year period. ARCADIS recommended that the area continue to be monitored to allow for natural attenuation effects to continue. ARCADIS presented this request along with site information and data trends to the USEPA and MADEP, and it was agreed that this area should just be monitored and natural attenuation allowed to continue instead of active remediation. Analytical data from March, June, and September 2006 indicate that PCE concentrations for all wells in the North Plume Area are within MCLs; however, these wells will continue to be monitored for a period of time to confirm recent data.

3.4.2 Secondary Water Quality

Inorganic compounds including iron, manganese and arsenic are solubilized within the reducing zones created by ERD technology. Inorganics solubilized within the reducing In-situ Reactive Zones (IRZs) are also not expected to migrate beyond the boundary of the zone of reducing conditions, and are not expected to persist once the prevailing aerobic groundwater environment is restored. Outside of the zone of reducing conditions (i.e., under the naturally aerobic conditions present in the groundwater at AOC 50) the inorganic constituents will be oxidized and subsequently immobilized through precipitation and/or adsorption. However, if groundwater monitoring data indicate that the inorganics have not attained remediation goals (if dissolved arsenic fails to re-precipitate) following completion of the ERD application, then a contingency remedy would be implemented.

A contingency remedy associated with dissolved inorganic compounds downgradient of the final ERD transect (i.e., upgradient of the IWS system) will be implemented in the event that elevated arsenic concentrations are detected in the Sentinel Wells located upgradient of the IWS wells. The contingency remedy to be implemented in that case may consist of the addition of amendments into the aquifer such as a supplemental dissolved iron source or other amendments if needed to re-precipitate dissolved arsenic. The amount and type of amendments would be determined based on the groundwater geochemistry and performed on an as-needed basis to establish and maintain the necessary conditions for arsenic precipitation. Field parameter measurements and inorganic groundwater samples will be collected in accordance with the Long Term Monitoring Plan (ARCADIS 2006) for the site to confirm the desired conditions, and the monitoring of the Sentinel Well network will be conducted to assure the success of the contingency remedy.

In addition, after the ERD remedy is completed within sections of the plume and injection transects are phased out (which is expected to be approximately 10 to 15 years based on the groundwater modeling prepared in the Feasibility Study (FS) and updated as part of the 60% remedial design), the inorganic data collected during the long-term monitoring will be evaluated to assess that adequate restoration of natural aerobic conditions and re-precipitation of inorganics have been achieved. If warranted, the re-precipitation of inorganics will be expedited through manipulation of aquifer chemistry or application of more effective treatment technologies along the length of the plume utilizing existing ERD injection wells as transects are phased out following the treatment of VOCs.

4.0 DEMONSTRATION OF OPS

The components of the full-scale remedial system were installed between July and September 2004 following approval of the Area of Contamination (AOC) 50 Remedial Design (RD) in July 2004. In September 2004, all components of the full-scale remedy at AOC 50 including the enhanced reductive dechlorination (ERD), in-well stripping (IWS), and soil vapor extraction (SVE) systems were in operation. Details supporting the proper and successful operation of these systems are included in the following sections.

4.1 Remedial Action Objectives

The remedial action objectives (RAOs) are site-specific clean-up objectives established to protect human health and the environment. The qualitative RAOs for the site as described in the ROD include:

- Minimize, stabilize or eliminate further migration of the groundwater contaminant plume within AOC 50 (containment); and
- Reduce the concentration of chemicals of concern (COCs) in groundwater to the chemical-specific cleanup levels, within a reasonable timeframe (aquifer restoration). The chemical-specific cleanup levels are defined in the following sections.

The specific RAOs for AOC 50 are described in the ROD and the RD for the various components of the remedy as follows:

ERD System: The objective of the ERD implementation is to expedite the degradation of CVOCs in the groundwater by stimulating microbial activity via electron donor addition. Sustained organic carbon concentrations are supplied during ERD activities to serve as the electron donor supporting biological CVOC degradation within the treatment area.

IWS System: The IWS application is intended to reduce the potential for migration of elevated concentrations of VOCs downgradient towards the Nashua River, thereby mitigating potential future ecological risk. In addition, the IWS application will provide an aerobic and oxidizing barrier capable of curtailing the potential downgradient migration of dissolved inorganic compounds and PCE degradation products that could be associated with the ERD application.

SVE System: Operation of the SVE system in the Source Area should provide indirect remediation of groundwater impacts by the removal of recoverable CVOC mass in the unsaturated zone. Specifically, the capture of adsorbed phase mass potentially present in the vadose zone soils removes a potential continuing source for groundwater contamination. As noted previously, the SVE system achieved these remedial objectives and was shut down in November of 2005 with concurrence from the Base Cleanup Team (BCT). The SVE system will not be considered further in this OPS demonstration.

4.1.1 Groundwater Restoration Goals

Groundwater cleanup levels were established in the ROD for all COCs, which in most cases is based on applicable or relevant and appropriate requirements (ARARs). Because the aquifer under the Site is a Class I aquifer, which is a potential source of drinking water, MCLs established under the Safe Drinking Water Act and any more stringent state groundwater quality standards are ARARs. The groundwater restoration goals are therefore considered the MCLs (with several exceptions). **Table 2** presents a complete summary of the cleanup levels for all of the COCs in groundwater as well as risks and hazards associated with cleanup levels. Primary MCLs have not been established for iron and manganese. Risk-based concentrations were derived in **Table 2** for these constituents based on default exposure assumptions for child residents (i.e., the most highly exposed and susceptible receptor), published reference doses, and a target hazard index of one.

Cleanup levels at this Site must be met throughout the contaminated groundwater plume, which extends from the North Plume and Source Area along Route 2A to the Southwest Plume and the Nashua River. The boundary of this plume is shown on **Figures 4 through 7**. Attainment of groundwater cleanup levels will be determined through a long-term monitoring program that has been implemented as part of the remedy and are expected to be achieved within approximately 23 years after implementation of the full-scale remedy.

4.1.2 Porewater Cleanup Levels

Cleanup levels have been established for porewater for COCs that pose an ecological hazard quotient for benthic invertebrates greater than 1, including 1,2-dichloroethylene, lead, manganese, and PCE. cleanup levels for porewater have been set based on chronic freshwater ambient water quality criteria (USEPA 2002), final chronic values (MDEQ 2002), and chronic Tier II values (Suter 1996) (in descending order of preference). These concentrations reflect levels reported in the scientific literature to be without deleterious effect on aquatic organisms. Because these cleanup levels are specific to porewater, the point of compliance may be either; a) groundwater located as close as is practical to the Nashua River and downgradient of the In-well Stripping remedy or b) the porewater within the uppermost six inches of sediment of the Nashua River. Cleanup levels for porewater are presented in **Table 3**. These porewater cleanup levels must be met at the completion of the remedial action at the points of compliance. They are consistent with ARARs for surface water, attain USEPA's risk management goals for remedial action, and are protective of the environment.

4.2 Remedy Performance Criteria

Federal agency sites undergoing remediation under CERCLA are considered to be operating properly when they are "***operating as designed***". This definition was developed by the Office of Solid Waste and Emergency Response (August, 1996) when applied to federal sites involved in the transfer of property. This definition is further explained as applying to the ***construction, operation, and monitoring components*** of the remedial system. This guidance was used to develop the remedy-specific criteria listed below for the primary remedial technologies.

"***Successful***" operation of a remedial system at these same type of federal sites is defined as "***its operation will achieve the cleanup levels or performance goals delineated in the decision document***", additionally, "***that remedy must be protective of human health and the environment***" (Office of Solid Waste and Emergency Response, Interim document, August, 1996).

A summary of the criteria to demonstrate both ***"proper"*** and ***"successful"*** operation of the ERD and IWS remedies are presented in **Tables 4** and **5**, respectively. These tables include the supporting evidence needed to demonstrate that the criteria have been met. The site- and process-specific supporting details are provided below.

4.3 ERD System Proper Operation

The proper operation of the ERD system is demonstrated by the successful implementation of ERD activities at Area 5 (the initial ERD pilot test area) and the implementation and current development of ERD processes at the other ERD/IRZ areas. As proposed, over 40 injection wells were installed across the site and used for the injection of carbon substrate into impacted groundwater zones. Since the installation, injection infrastructure has been utilized to effectively deliver approximately 10,000 gallons of substrate on a monthly basis. In addition, an ongoing long-term groundwater monitoring plan was developed and implemented for site-wide wells. A complete summary of these activities is presented in the following sections, and summarized in **Table 4**.

4.3.1 Construction of ERD System

The proper as-built construction of the ERD system is documented in the Remedial Design (ARCADIS, July 2004b) and the O&M Manual (ARCADIS, July 2005b). As presented in **Table 4**, injection infrastructure (43 injection wells, injection trailer, storage area) were constructed as designed to facilitate injection of the carbohydrate solution.

4.3.2 Operation of ERD System

Full-scale injection events at AOC 50 began in September 2004 and have been conducted on a monthly basis. During each event, 10,000 gallons of substrate is delivered to 43 injection wells as detailed in regular quarterly and yearly O&M reports. **Table 6** presents a summary of the monthly injection events including the solution content, injection flow rates, and well head pressures. As shown, the well-specific injection flow rates and corresponding well head pressures have remained consistent during the period of operation. This indicates that the formation can receive the design injection volume. Additionally, it demonstrates that the formation has remained unaffected by the TOC injection program.

As demonstrated in the Area 5 (former pilot test) ERD zone, sustained total organic carbon (TOC) delivery supports the development of biostimulation effects and the creation of ERD/IRZ zones. Since the initiation of the full-scale program, carbohydrate injections in each treatment area have resulted in TOC distribution within the subsurface, thereby facilitating the development of additional ERD/IRZ zones.

Figures 8 through **10** present the aerial distribution of TOC in each of the ERD areas. In addition, **Figures 11** through **16** provide summary plots of the TOC data (along with other standard ERD operating data) for each of the ERD areas and demonstrate the distribution of TOC within the ERD/IRZ. The 10% dilute molasses solution was selected for AOC 50 such that TOC concentrations would be available downgradient of injection locations. During propagation of the IRZ, bioavailable TOC concentrations (above background TOC levels) are anticipated to exist within 100 ft downgradient of the radius of influence from the injection well. This distance corresponds to the maximum approximate distance which sucrose (molasses) can be maintained in the subsurface. As shown on **Figure 12**, TOC concentrations within the Former Drywell (FDW)-NE Area are approximately 3,000 mg/L in well G6M-02-08X, 10 feet downgradient of the injection well. Additionally, wells G6M-03-02X and G6M-96-13B show that TOC concentrations are still elevated at distances of 15 and 25 feet, respectively.

This trend is apparent in other IRZ areas, as shown by the Former Drum Storage Area (FDSA) well G6M-04A-10A (**Figure 13**), Area 2 well G6M-97-08B (**Figure 14**), Area 3 well G6M-03-7X (**Figure 15**), Area 4 well G6M-02-13X (**Figure 16**), and well MW-3 in the pilot study area (**Figure 11**). As shown in the Area 2, 3, and 4 performance monitoring wells (**Figures 14-16**), peak historical TOC concentrations have been observed between 250 and 300 mg/L at a distance of 60 feet downgradient. These concentrations are similar to the maximum values observed within the most active ERD regions of the plume (Area 5). This indicates that monthly injections are properly supplying TOC within each of the IRZ areas, and that these concentrations are sufficient to sustain active ERD processes.

4.3.3 Monitoring of ERD System

The existing monitoring and injection well network at AOC 50 is presented on **Figures 4** though **7**. As detailed in **Table 4**, a long-term monitoring plan was presented and approved for each of the areas within AOC 50; these results are presented in **Table 1**. The performance monitoring wells used for the evaluation of each ERD/IRZ are located downgradient of each injection transect, and as detailed in the O&M Manual are used to optimize the ERD process. Area-specific performance results are discussed in detail in Section 4.4.

4.4 ERD System Successful Operation

The primary evaluation criteria for the successful operation of the ERD system and the associated supporting data and analysis are discussed in the following sections. Specific criteria used to validate the successful operation of designed ERD systems are summarized below:

- Sustained TOC concentrations over time in monitoring wells throughout the treatment areas;
- Appropriate pH levels for dechlorination: between 5 and 9 (satisfactory), and 6 and 8 (preferred);
- Increased methane production indicating that methanogenic conditions are present in the treatment areas;
- Degradation of parent species (PCE) and production of daughter products (TCE, cis-1,2-DCE, vinyl chloride (VC), and ethene); and
- Subsequent degradation of chlorinated daughter products in a fully-developed IRZ.

ERD operations were initiated in Area 5 approximately five years ago, and the IRZ at Area 5 is fully developed. ERD operations began in the other areas in September 2004, and so the IRZs are not as fully developed in these areas compared with Area 5, which has received more than five years of regular molasses injection. The OPS demonstration for the ERD system will therefore focus on the results at Area 5, which are representative of a mature IRZ. The results from the other areas will be compared with the trends observed during IRZ development at Area 5 in order to demonstrate successful progress in the development of the IRZs in the other areas. The data presented and discussed in the following sections demonstrate successful operation of the Area 5 ERD, and show that the other ERD/IRZs are developing similarly (i.e. showing the same trends) as Area 5.

4.4.1 Biostimulation and Development of Anaerobic Conditions

The successful implementation of the ERD process is initiated through in-situ biostimulation and the development of anaerobic conditions in groundwater. Biostimulation occurs through the regular delivery of organic carbon throughout the treatment area. Increased TOC concentrations and alkalinity in monitoring wells indicate successful biostimulation in response to molasses injections. Anaerobic conditions develop when TOC concentrations are high enough to support the biological depletion of competing electron acceptors. Strongly reducing (methanogenic) conditions required for enhanced dechlorination of PCE and TCE are indicated by increased concentrations of methane in monitoring wells.

Monitoring data collected during the implementation of the ERD technology are presented in **Table 1. Figures 11** through **16** present key parameters in graphical form to demonstrate successful operation of the ERD remedy, specifically each figure shows trends in dissolved iron and arsenic, pH, TOC, methane, and chloroethenes. A summary of the results from each ERD area is presented below.

TOC Distribution. As discussed in Section 4.3.2, the implementation of the ERD remedy has resulted in the distribution of TOC within groundwater in all targeted ERD areas (FDW and FDSA Areas, Area 2, Area 3, Area 4, and Area 5). The implementation of ERD through regular molasses injection has achieved successful distribution of TOC throughout the treatment areas, and supported biostimulation through the degradation of TOC resulting in the stimulation of strongly anaerobic (methanogenic) conditions. Generally, increased methane concentrations are observed approximately six to 12 months after the first arrival of adequate TOC concentrations.

Methane and Biostimulation. **Figure 11** shows the methane trends during development of the IRZ in the pilot area (Area 5). During the initial year of pilot operations, methane levels were relatively low (0 to 5,000 ppb) in the pilot area. Once adequate distribution of TOC was achieved (100 to 270 ppm), methane levels increased significantly. Since then, methane trends within the pilot study area have remained consistently above 20,000 ug/L for approximately four years. As presented on **Figures 12** through **16**, similar trends in methane production are observed in the other IRZ areas within the past 12 months of molasses injection. Within the FDW Area, after elevated TOC concentrations had been observed in well G6M-03-02X, a lag period of approximately 10 months was observed prior to significant methane production (**Figure 12**). Similarly, a lag time of approximately nine months was observed in FDSA well G6M-04-10A between the arrival of injected TOC and the onset of methane production (**Figure 13**). In addition, these lag periods are consistent with those observed in Areas 3 and 4. As shown on **Figure 14**, increased TOC concentrations were observed in the September 2006 sampling event in Area 2 well G6M-97-08B. Thus, it can be expected that a similar methane response will be observed in the next two sampling periods. Slower than expected response rates in Area 2 may be the result of slightly slower than expected groundwater velocities. However, these data indicate that the molasses injection program is supporting enhanced biostimulation as designed and that the necessary conditions for dechlorination are being established.

Metals Reduction. As outlined in the Final FS (ARCADIS, 2002), inorganics such as ferrous iron and arsenic will be solubilized within the reducing IRZs but are not expected to be observed beyond the boundary of reducing conditions. Arsenic solubility is strongly controlled by aqueous iron concentrations, and arsenic/iron precipitates form in oxygenated groundwater (e.g. IRZ recovery zones). Thus, to ensure that downstream solubilization migration of dissolved metals does not occur, iron concentrations must be in excess of arsenic within the reduced IRZ. **Figure 17** demonstrates that even after five years of operation, solubilized arsenic is still restricted to the ERD zone even though the groundwater travel time through the ERD zone is estimated at approximately 300 days. By comparison, the Area 5 IRZ has been in operation for approximately 1,700 days. This indicates that solubilized arsenic within the ERD zone is not migrating with groundwater to locations outside the ERD zone. Finally, as shown on **Figure 18**, the ratio of dissolved iron to arsenic in all monitoring locations is greater than 100 to 1.

Generally, pH levels within each of the ERD zones have fluctuated between 5 and 7 since monitoring activities began. Although several data quality outliers have been observed during the monitoring period, the observed pH levels are conducive to dechlorination. During the September 2006 sampling period, pH values in the IRZ monitoring wells were between 5.2 and 6.56 (**Figures 11-16**).

4.4.2 Enhanced Contaminant Degradation

The ultimate objective of the ERD system is to support the complete dechlorination of PCE within the IRZ. The following text presents the enhanced dechlorination trends observed within the IRZ areas, beginning with Area 5. As described above, ERD operations have been ongoing in Area 5 for five years and thus a fully developed IRZ is present. The trends observed in Area 5 are used as a predictor of the results for other areas where IRZ development is still in the earlier stages. As will be demonstrated, each of the ERD areas show similar degradation characteristics to those observed in Area 5.

The key monitoring trends used to assess the extent of enhanced contaminant degradation include:

- Decline in PCE concentrations over time.
- Transient increase in degradation product cis-1,2-DCE as PCE declines.
- Decline in cis-1,2-DCE and production of advanced degradation products VC and ethene.
- Eventual decline in total chloroethene molarity as advanced degradation products dominate.

The monitoring data for each IRZ area are presented on **Figures 11 - 16**. Each figure presents trends in the molar concentrations of PCE and associated degradation products. The ERD monitoring data are included in **Table 1**.

Area 5 (Former Pilot Test Area) As discussed in the previous section, molasses injection in Area 5 has successfully created the strongly reducing conditions necessary for complete dechlorination of PCE. As shown on **Figure 11**, enhanced dechlorination of PCE and TCE to cis-1,2-DCE was observed within the first year of ERD operations. As the IRZ continued to develop, advanced dechlorination to VC was observed after approximately three years of molasses injection. At the same time, the total CVOC molarity has declined over time since molasses injections began. Finally, complete dechlorination to ethene was observed almost four years after molasses injection began. As of September 2006, ethene is the dominant compound in the Area 5 ERD zone, as it is present at concentrations higher than PCE, TCE, cis-1,2-DCE, and VC on a molar basis.

PCE concentrations in 2006 have fluctuated over time (between less than 2 ug/L and 620 ug/L) and appear to be influenced by molasses injections (i.e. enhanced dissolution in response to transient increased TOC levels) and heterogeneity within the plume. As of September 2006, PCE levels in Area 5 have been reduced by approximately 92% (as compared to pre-injection concentrations) within the ERD zone. Additionally, the total CVOC concentration fluctuated between 0.23 to 11.29 mmol/L during 2006, corresponding to an approximately 99% to 74% reduction in total CVOC levels since molasses injection began.

As shown on **Figure 11**, cis-1,2-DCE was the predominant chlorinated constituent for approximately two years of operation (November 2002 to November 2004), after which these concentrations have slowly declined. As mentioned previously, this decline corresponded with approximately one year of VC predominance. Although these time periods and CVOC trends may not be exactly correlative in each area at increasing distance, they are used for comparison purposes in order to assess the productivity of the other ERD areas.

Former Drywell (FDW) Area **Figure 12** presents the results from three well locations downgradient of the FDW injection transect. TOC concentrations are elevated in each of these locations, and decline sequentially with distance away from the injection wells (4,400 to 1,300 to 300 ppm, respectively). TOC delivery to each of these locations has resulted in developing ERD conditions, including methanogenesis and the production of chlorinated daughter products. As observed in well G6M-03-02X (15 feet downgradient), the onset of methanogenesis was observed approximately 7 months after the first observance of injected TOC. In addition, methane production was also observed in September 2006 at G6M-96-13B (25 feet downgradient) where TOC concentrations are lower (**Figure 12**), indicating that the IRZ is developing further away from the injection transect.

In the well nearest the injection transect (G6M-02-08X), cis-1,2-DCE currently accounts for over 92% of total CVOCs, and similarly predominates in the two further downgradient wells. Cis-1,2-DCE generation in all three locations was preceded by the arrival of TOC. As shown, total CVOC concentrations are still elevated, but each well location within the FDW area exhibits characteristics of the early stages of dechlorination, and are comparable to trends observed in Area 5 after 12 to 18 months of operation. These results indicate that ERD development is proceeding as anticipated.

Former PCE Drum Storage Area (FDSA) As presented on **Figure 13**, TOC impacts in the FDSA area are apparent 23 feet downgradient of the source area. Elevated concentrations have been observed for over 12 months, generating reducing conditions that support methanogenesis. It is apparent in PCE data collected between March and June 2006 that injection into the source area caused the enhanced dissolution of sorbed PCE to groundwater at well G6M-04-10A. The increase and subsequent decrease in PCE and TVOC concentrations in the last six months is correlated with elevated methane concentrations. and decreasing TOC trends. Conversion to cis-1,2-DCE is occurring, and the onset of reducing conditions in this area indicates that the ERD and dechlorination will continue to develop.

Area 2 **Figure 14** presents data collected from well G6M-97-08B, which is approximately 60 feet downgradient of the injection well transect in Area 2. Prior to

September 2006, elevated TOC concentrations had not been observed at this location, and thus the response in geochemical conditions (i.e. elevated ferrous iron and methane) was not observed . However, an increase in TOC concentration (270 mg/L) during the most recent sampling event indicates that injection events have succeeded in delivering electron donor to this area. The presence of cis-1,2-DCE indicates that some enhanced dechlorination is occurring; however, the presence of PCE at levels greater than that of cis-1,2-DCE confirms that the process is still in the very early stages. This is expected given the only recent detection of TOC at the monitoring location. It is expected that continued development of the IRZ in this area will proceed resulting in a decline in PCE and continued production of cis-1.2-DCE, and ultimately ethene.

Area 3 **Figure 15** presents the data from well G6M-03-07X, located 60 ft downgradient of the injection well transect in Area 3. As described in the previous section, significant TOC levels (approximately 300 mg/L) are present in this area. These TOC levels support methanogenic activity within Area 3. Enhanced dechlorination of PCE to cis-1,2-DCE occurred coincident with the onset of methanogenesis in late 2005. Since then, enhanced dechlorination of cis-1,2-DCE to VC is observed, and ethene concentrations have increased in the most recent sampling events. Although this well location is 60 feet downgradient of the injection well transect, extremely positive results are observed. It is expected that the dechlorination trend will continue resulting in the decline in VC and continued increase in ethene levels prior to complete degradation.

Area 4 The results from Area 4, presented on **Figure 16**, show the same trends as Area 3. Similar to Area 3, significant TOC and methane are observed, indicating that conditions are appropriate for enhanced dechlorination. As seen in Area 3, dechlorination to cis-1,2-DCE was observed once adequate TOC was present in the area and methanogenic conditions were achieved. Subsequent dechlorination of cis-1,2-DCE to VC, as well as ethene, is observed in the more recent sampling data. As the dechlorination process continues, increased ethene production will continue as observed in Area 5.

4.4.3 Contaminant Degradation Rates Consistent with Model

As described above, implementation of the ERD technology is most advanced in Area 5, where the pilot test began in 2001. Monthly injections began in December 2001 and have supported a well-established and robust dechlorinating environment. Because of the advanced development of the IRZ, Area 5 provides the best opportunity to calculate the in situ PCE degradation rate. The PCE degradation rate can then be compared to that predicted by the model to further demonstrate the successful operation of the ERD remedy.

Degradation rates for PCE and TVOCs were calculated from a series of performance monitoring wells in Area 5 (**Figure 19**). This series contains four wells located perpendicular to the injection wells in Area 5 (including one upgradient), all of which are within 100 feet of the injection wells. Data from both March 2004 and September 2006 were considered in these rate calculations to draw out changes in the ERD zone during this time period. These rates were then compared to the PCE and TVOC half-lives of 25 and 75 days, respectively, as determined by the groundwater model during the remedial design phase.

As shown on **Figure 19**, the 2004 data indicate that within the Area 5 ERD zone, the apparent PCE and TVOC half-lives are approximately 11 and 70 days, respectively,. The faster PCE degradation rate within the reactive zone (11 days) better reflects the actual PCE degradation rate in the presence of TOC, and the apparently longer degradation rate across the entire ERD zone (70 days) accounts for the sequential degradation of intermediate compounds such as TCE, cis 1,2-DCE, and VC. Additionally, each of these half-lives is consistent with those predicted by the groundwater model.

Results from September 2006, however, indicate that the degradation of both PCE and TVOC within the IRZ is occurring faster than observed historically. The half-lives for PCE and TVOC were 7 and 20 days, respectively. This indicates that although complete conversion of PCE to ethene is occurring, dechlorination rates within Area 5 are still increasing.

Similar degradation analyses were completed with data from the other ERD areas, but the variable PCE concentrations and travel times across the length of the plume make it difficult to apply a general site-wide degradation rate downgradient from all injection transects. As discussed; however, PCE degradation trends observed in data from each ERD zone are similar to those observed in the former pilot test area during development of the Area 5 ERD zone. Therefore, as the individual ERD areas continue to develop along Areas 1, 2, 3, and 4, similar PCE and TVOC degradation rates will be observed.

As shown on **Figure 19**, the degradation rates estimated using site data are consistent with the rates used in the groundwater model to determine the remedial timeframe. The estimated degradation rates determined using site data are faster than those proposed by the model, indicating that remediation should be complete within the estimated timeframe determined with the groundwater model (approximately 23 years). The additional time required for full development of the multiple ERD zones across the site such that the observed degradation rates are similar to Area 5 may take an additional one to three years. The analysis of site data and associated determination of these degradation rates supports the following conclusions:

1. PCE degradation rates are consistent with the model predictions and are consistent with the data and trends observed in Area 5 (the former pilot test area).
2. Degradation rates of VOC by-products (cis-1,2-DCE, VC) are consistent with the model predictions for Area5.
3. Overall degradation rates of total VOC are sufficient to meet the AOC 50 ROD groundwater restoration time-frames.

4.4.4 ERD Protective of Human Health and the Environment

The ERD process is protective of human health and the environment in that it will achieve the remedial goals for groundwater and it is degrading the PCE in-situ in a generally non-invasive manner. This process has been demonstrated in Area 5 and is being implemented across the site at the other ERD areas.

The ERD process can cause limited, transient, water quality issues within an ERD zone due to the reducing conditions established and the solubilization of iron, manganese and arsenic. As discussed in Section 4.4.1, proper operation of the ERD process has limited these transient inorganic water quality issues to within the ERD zone, and the dissolved arsenic water quality standard (10 ppb) has not been exceeded outside of the established ERD/IRZs.

4.4.5 ERD Process Attainment of Remedial Action Objectives

The ERD remedial process at this site is on track to achieve the remedial goals within the currently estimated timeframe of approximately 23 years. PCE concentrations have been reduced significantly throughout the Source Area and Southwest Plumes and it is expected that concentrations will continue to decrease. Degradation by-products including cis-1,2-DCE and VC are being produced in these areas, and should degrade to ethene as they have and will continue to do in the more established ERD zone of Area 5. Continued development of the ERD zones throughout the Southwest Plume and in the Source Area will continue to accelerate the rate of remediation and should achieve the remedial goals within than the estimated 23 years.

4.5 IWS System Proper Operation

The primary criteria for the proper operation of the IWS system as designed are listed below with the supporting evidence.

4.5.1 Construction of IWS System

The proper construction of the IWS system has been demonstrated with the following activities and documentation:

1. Installed two IWS wells with mechanical and control components as designed.

2. Completed start-up and shake-down of IWS system as summarized in the start-up report (ARCADIS, October 2004c).

3. Completed and submitted approved O&M manual with as-built drawings for IWS system as designed (ARCADIS, July 2005b).

4.5.2 Operation of IWS System

The proper operation and maintenance of the IWS system has been demonstrated with the following activities and system operation as documented in **Table 5**:

1. Both IWS wells are pumping, recirculating, and treating groundwater at approximately 20-30 gallons per minute (gpm) total, which is in excess of the PCE-impacted groundwater flow into the area.

2. Delivering sparge air to treat groundwater and treating the extracted and re-injected groundwater by significantly lowering the PCE concentration.

3. Saturating the groundwater with dissolved oxygen within the well at the design pumping rate.

4. Established effective plume capture zone and radius of influence as presented in IWS start-up report (ARCADIS, October 2004).

5. O&M manual completed and approved (ARCADIS, July 2005b).

6. Established and demonstrated effective capture zone and radius of influence during start-up of IWS system (ARCADIS, October 2004); **Figure 20** presents the estimated capture zone from the start-up summary report.

7. On-going operation and monitoring with operational uptime for the two IWS wells of 92%.

8. Quarterly O&M Reports submitted for 2004, 2005, and 2006 and annual report submitted for 2005; **Table 7** presents the summary of the IWS system data to date.

4.5.3 Monitoring of IWS System

The proper monitoring of the IWS system has been demonstrated with the following activities and documentation:

1. Installation of downgradient wells G6M-04-06X and G6M-04-07X and upgradient wells G6M-04-05X and G6M-03-08X for IWS system monitoring.

2. Monitoring VOC treatment/removal effectiveness of each IWS well on a monthly basis; **Table 7** lists the results of this regular sampling.

3. Monitoring in-situ effectiveness of IWS system at downgradient Wells G6M-04-06X and G6M-04-07X and upgradient Wells G6M-04-05X and G6M-03-08X; **Table 1** lists the results of this sampling along with the site-wide monitoring data.

4.6 IWS System Successful Operation

The primary evaluation criteria for the successful operation of the IWS system and the associated supporting data and analysis are listed in the following sections.

4.6.1 PCE Mass Removal in IWS Area

The removal of PCE mass from the groundwater in the IWS area has been on-going since the initial start-up of the IWS system in May 2004. The rate of PCE mass removal is controlled by the extent of the IWS system capture zone and the PCE concentrations in the groundwater flowing into this capture zone. The IWS system has removed approximately 25 pounds of PCE from groundwater and has significantly lowered the PCE concentrations in the groundwater in the IWS area and at downgradient locations. The two IWS wells operate at a combined flow rate greater than the groundwater flow rate into the IWS capture zone. Therefore, the extracted groundwater is treated for PCE removal with multiple passes through the IWS system. This allows for greater than 90% overall removal efficiency of PCE from the groundwater in the IWS area. The summary of the operational mass removal data is presented in **Table 7**. This data supports the following conclusions on the IWS system:

1. Removing approximately 90% of PCE mass in groundwater flowing into the IWS capture area.
2. Established effective plume capture zone and radius of influence as presented in IWS start-up report (October 2004).
3. Reduced PCE concentrations at downgradient well G6M-04-07X from 1,100 ppb on 12/17/04 to 150 ppb on 06/23/06, an 85% reduction in groundwater PCE concentrations. This has occurred while the concentrations of PCE in upgradient well G6M-03-08X has remained relatively the same during this period (750 vs. 610 ppb). This is documented in regular quarterly and annual O&M reports; **Figures 4 and 7** show the PCE concentrations at these wells during the IWS operational period.

4.6.2 Develop an In-situ Aerobic Barrier

The IWS system has been transferring dissolved oxygen into the aquifer to create an aerobic zone as a post-ERD polishing treatment at the downgradient end of the Southwest Plume. The steady state transfer rate of dissolved oxygen is set based on the flow rate of the wells and maximum dissolved oxygen levels that can be obtained with the process. The operational data indicates that the treated effluent from the IWS wells contain dissolved oxygen at the saturation limit (approximately 10 mg/l). The system operational data and the site monitoring data therefore support the following conclusions on the IWS system:

1. Pumping at approximately 20-30 gpm (total), this is excess of the GW flow into the area.
2. Delivering sparge air at approximately 80-100 cfm per well and raising DO levels to saturation.
3. Transferring approximately 1.4 lbs/day of oxygen to groundwater, or a total of approximately 1010 pounds to date.
4. Reduced iron has not been detected at or impacted operation of the IWS wells.

5. Downgradient wells G6M-04-06X and G6M-04-07X generally show elevated DO and ORP levels compared to upgradient wells G6M-04-05X and G6M-03-08X.

4.6.3 IWS Protective of Human Health and the Environment

The IWS system is protective of human health and the environment as it is directly removing PCE mass from the groundwater at the downgradient edge of the Southwest Plume, and it is protecting the adjacent surface water body (the Nashua River) from discharges of groundwater with elevated PCE levels or unusually high metals levels. The IWS process achieves this through the stripping and removal of PCE from groundwater and the addition of dissolved oxygen to groundwater. The zone of elevated dissolved oxygen by the IWS operation intercepts reduced groundwater flowing out of the Area 5 IRZ, oxidizing reduced metals and accelerating restoration of the natural aerobic poise. The aerobic environment may also enhance the degradation of PCE transformation intermediates such as cis-1,2-DCE and VC. The addition of dissolved oxygen oxidizes reduced metals in the groundwater and also creates a "buffer" zone of dissolved oxygen to counter-act the lower dissolved oxygen groundwater that may flow from the ERD zones at the upgradient locations. This aerobic buffer also acts to provide oxygen for supplemental aerobic degradation by-products from the anaerobic ERD process such as cis-1,2-DCE or VC and also provides oxygen to oxidize reduced metals if present.

4.6.4 IWS System Attainment of Remedial Action Objectives

The IWS system has been able to achieve its remedial action goals of lowering PCE concentrations at the downgradient end of the Southwest Plume and to create an aerobic buffer at the downgradient end of the Area 5 ERD zone. The remedial goals for the IWS were more limited in scope, and were developed as a somewhat redundant remedial process to protect the downgradient areas and the Nashua River.

4.7 Real Estate Issues and Land Use Controls

Until such time as the Army demonstrates the remedial actions to be operating properly and successfully, Parcel A5 **(Figure 3)**, which covers the Source Area, will remain under a long-term lease agreement with Mass Development in anticipation of eventual deeded transfer of the leased property. This lease agreement contains land use controls (LUC) or institutional controls (ICs) and restrictions necessary for protection of human health and the environment and to ensure continuation of the US Army's remedial activities during the lease period. These controls and restrictions are monitored by the US Army as part of lease oversight activities. The general approach to the property transfer and associated LUC are presented in the following section. The LUCs also apply to Parcels H, A.16, 4, and 1E for the Southwest Plume and the Merrimack Warehouse and GFI Ayer, LLC parcels for the North Plume **(Figure 3)**. Should the U.S. Government decide to excess Parcel H out of federal ownership, this OPS demonstration would also serve to meet the statutory requirements of CERCLA 120(h)(3). The specific steps and actions required for the three areas of the plume are described in the subsequent sections.

4.7.1 Deed Restrictions

The Army will circulate the findings of suitability to transfer (FOST) of the property to be transferred, but before executing the deed for conveyance, a copy including Environmental Protection Conditions will be provided to the property owner, USEPA and MADEP so they may have the opportunity, before document execution, to review and concur in accordance with their legal authorities. In addition, the deed restrictions will be recorded with the chain of title for the transferred property. It is agreed that the provisions in the deed will:

Be consistent with the essential restrictions and controls specified in the FOST;

Be consistent with state real property law and be made to run with the land so that they shall be binding on subsequent owners of the property, unless or until each LUC is released, and shall include a legal description of the property where the LUCs are to be implemented;

When the property is transferred outside of federal ownership, consistent with state real property law, Army shall provide that, upon transfer, MADEP be granted with post-transfer enforcement rights to address transferee(s) or user(s) violations of LUCs imposed as part of Army's CERCLA remedy;

Provide that the Army shall not significantly modify or release any LUC without prior USEPA and MADEP concurrence, in accordance with their respective legal authorities;

Contain a reservation of access to the property for the Army, USEPA, MADEP, and their respective officials, agents, employees, contractors, and subcontractors for purposes consistent with the Army Installation Restoration Program (IRP) or the Federal Facilities Agreement (FFA).

4.7.2 Lease Restrictions

During the time prior to the deeding of the property, equivalent restrictions shall remain in place by lease terms, which are no less restrictive than the use restrictions and controls described here and in the following sections. These lease terms shall remain in place until the property is transferred by deed, at which time they will be superceded by the controls described herein.

4.7.3 Notice

Prior to transfer of a property, should the Army discover activity on a property inconsistent with the LUC performance objectives, the Army shall notify the USEPA and MADEP with 72 hours of such discovery. The board of health, property owner, and DEC will also be notified. Activities that are inconsistent with the IC objectives or use restrictions, or other actions that may interfere with the effectiveness of the ICs will be addressed by the Army, property owner, local board of health and the DEC, or Fish and Wildlife Service (depending on the portion of the Site) as soon as practicable, but in no case will the process be initiated later than 10 working days after becoming aware of the breach. The USEPA and the MADEP will be informed regarding how the breach has or will be addressed within 10 working days of sending USEPA and the MADEP notification of the breach or inconsistent activity. Where the property has been transferred, the Army, USEPA, and MADEP will work together with the new owner of the property to correct the problem(s) discovered. The transfer or other appropriate documents shall provide that, post-transfer, the new property owners will be responsible for providing notification to the appropriate regulators, Army and/or local government representatives, reporting LUC problems, deficiencies or violations, so any issues can be resolved quickly. This reporting requirement does not preclude the Army, USEPA, or MADEP from taking immediate action pursuant to CERCLA authorities to prevent any perceived risks to human health or the environment.

4.7.4 Monitoring

Annual physical inspections of the Site will be made to confirm continued compliance with LUC objectives and to ensure that future users of the Site are meeting the LUC performance objectives.

After inspection personnel have contacted the property owner in writing to provide a LUC RAWP questionnaire and remediation status updates, a physical on-site inspection of the property will be made to determine compliance with the LUCs. The physical on-site inspection will be conducted annually and shall include examination for evidence that the property is being used for acceptable land uses and that no groundwater extraction wells have been installed on the premises.

The Army will be conducting inspections on the North Plume, the Army with assistance from Mass Development and the DEC will be conducting inspections on the Source Area properties, and the Army with assistance from the Mass Development and DEC and US Fish and Wildlife Service will be conducting inspections on their respective portions of the Southwest Plume.

Inspection personnel will contact the property owner, its manager or designee with knowledge of the "day-to-day" activities of the property to make arrangements to review compliance with LUCs. As part of the interview, the inspector will inquire about the following:

The owner's familiarity regarding land use controls imposed upon the property and documentation of these controls;

Sources of water used at the property; and

Proposed plans for property sale, future development, construction or demolition activities at the Site.

Annual LUC compliance report will be provided to the USEPA, MADEP, and Devens Document Distribution list for the Site by the Army. In addition, should any deficiency(ies) be found during the annual inspection, a written explanation will be prepared indicating the deficiency and what efforts or measures have or will be undertaken to correct the deficiency and a schedule to correct the deficiency. If there is to be a transfer of responsibility, the Army will notify USEPA and MADEP and parties affected, of the shift in LUC management responsibilities.

The frequencies of inspections and reporting may be adjusted upon concurrence of the regulatory agencies based upon inspection results for the first year, in accordance with their respective legal authorities. Proposed changes in inspection and reporting frequency will be recommended in the annual report for regulatory review and concurrence prior to implementation.

Annual reports will be submitted to the Base Realignment and Closure (BRAC) distribution list, which includes USEPA, MADEP, land owners affected by the LUC RAWP and Restoration Advisory Board (RAB) members and the local communities. The annual report will include a summary of the interviews and physical site inspections with notification of breaches to the LUC RAWP, and corrective actions necessary as a result of changes in site conditions or land use, and proposed changes to inspection and reporting frequency. The annual report will also address whether the use restrictions and controls referenced in this Plan were communicated in the deed(s) and other legal instruments, whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed to such restrictions and controls.

4.7.5 Response to Violations

The Army will notify the USEPA and MADEP via e-mail or telephone as soon as practicable, but no later than ten days after discovery of any activity that is inconsistent with the LUC objectives, or use restrictions, or any action that may interfere with the effectiveness of the LUCs. Any violations that breach federal, state or local criminal or civil law will be reported to the appropriate civil authorities.

4.7.6 Enforcement

Should the LUCs reflected in the LUC RAWP fail, the Army, USEPA, and MADEP will work together to ensure that appropriate actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the owner or violator, to the institution of judicial action under the auspices of State property law or CERCLA. Alternatively, should the circumstances warrant, the Army, USEPA, and MADEP could choose to exercise its response authorities under CERCLA then seek cost recovery. Should the Army become aware that a user of the property has violated any LUC requirement where a local agency may have independent jurisdiction (local regulations and permits), the Army or future owner will notify the agencies of such violations and work cooperatively with them to re-achieve owner/user compliance with the LUC.

4.7.7 Notification of Land Use Modification

The Army, USEPA and the MADEP will be notified 60 days in advance of any proposed land use control, implementation actions, or land use changes that may be inconsistent with the LUCs or selected remedy. The notice, shall describe the mechanism by which LUCs will be changed to be protective or the prohibited land use will be prevented. The LUCs, implementation actions, or land uses shall not be modified or terminated without the prior written approval of the Army, USEPA, and the MADEP.

Prior to the deeding of Parcel A5, equivalent restrictions are being implemented by lease terms, which are no less restrictive than the use restrictions and controls described in this document and in the AOC 50 ROD. These lease terms shall remain in place until the property is transferred by deed, at which time they will be superseded by the institutional controls described in the AOC 50 ROD.

Concurrent with the transfer of fee title from the Army to transferee, information regarding the environmental use restrictions and controls will be communicated in writing to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property. The Army will provide a copy of the executed deed or transfer assembly to the USEPA and MADEP. The transfer documentation, such as the FOST, shall describe the mechanisms by which LUCs will continue to be implemented, maintained, inspected, reported on, and enforced, as well as the assumption of specific duties to be undertaken by the transferee and the new property owner. The Army further agrees to provide USEPA, MADEP, and affected parties with similar notice, within the same time frames as to federal-to federal transfer of property, if applicable. In accordance with the transfer agreement, the transferee will bear any cost associated with interference with the remedy and or modifications to LUC's, which necessitate additional cleanup. Furthermore, prior to seeking approval from USEPA and MADEP the recipient of the property must notify and obtain approval from the Army of any proposals for a land use change at a site inconsistent with the use restrictions and assumptions described in the ROD agreement.

4.8 Location Specific LUC Planning and Implementation

LUCs have been initiated in each area of the plume (i.e. North, Source Area, and Southwest), through formal negotiations between the U.S. Army and the different entities that own the properties overlying these areas **(Figure 3)**. LUCs in the form of institutional controls (ICs), such as deed restrictions, will be used to restrict land and groundwater use at the Site to prevent unacceptable risk for the duration of the remedy. In addition, the LUCs will protect the integrity and effectiveness of the selected remedy and provide access to maintain the remedy. The LUC objectives, design and planning approach, and implementation and enforcement steps for each area are discussed below.

4.8.1 North Plume LUC

The objectives of the LUCs in the North Plume include:

- protecting potential residential receptors from ingesting contaminated groundwater
- restricting groundwater pumping to avoid drawing the contaminated groundwater from the Source Area
- limiting construction in specified areas over the contaminated groundwater that would interfere with the operation of the remedy
- providing access to the site for monitoring/remediation

4.8.1.1 North Plume LUC Design and Planning

The Army has planned and prepared agreements for:

1) necessary access to operate and maintain remedial systems and provide access for groundwater monitoring; and,

2) land-use control measures restricting groundwater withdrawal and protecting the integrity of existing and proposed wells with the property owners (Merrimack Warehouse and GFI Ayer, LLC) to prevent exposure to groundwater and to protect the remedy.

4.8.1.2 North Plume LUC Implementation and Enforcement

The Army has obtained a signed agreement with Merrimack Warehouse containing the LUCs to meet the objectives outlined above. No agreement was executed with the owner of GFI Ayer, LLC; however, the LUCs will still apply to the property even though it is not impacted by the AOC 50 contamination. A secondary layer of LUCs for this portion of the plume will include, local permitting (including building and well), and Planning Board reviews with the Town of Ayer. The Town of Ayer Subdivision Control Regulations requires subdivisions located within 400 feet of public water and/or sewer systems to connect to the systems. This will restrict the installation of wells used for pumping groundwater and will allow Army input to restrict construction that would interfere with the operation of the remedy (and monitoring). The Army will work with the Town of Ayer to ensure conformance with the LUCs. State well regulations will also restrict the pumping of groundwater from the North Plume.

These LUCs shall be maintained until the hazardous substances in groundwater beneath the North Plume have been reduced to levels that allow for unlimited exposure and unrestricted use. The Army will implement, monitor, report on, and enforce these restrictions. The LUCs cover the limits of the Merrimack Warehouse and GFI Ayer, LLC properties. The North Plume area and the associated LUC limits are shown on **Figure 3**.

4.8.2 Source Area LUC

The objectives of the LUCs in the Source Area include:

- protecting potential residential and commercial/industrial receptors from ingesting contaminated groundwater
- protecting commercial/industrial workers from inhaling vapors released from groundwater used as "open" process water
- preventing potential construction/occupation of residential dwellings, schools/child care facilities and inhalation of vapors released from groundwater to indoor air
- restricting groundwater pumping and storm water discharge/recharge to avoid drawing the contaminated groundwater from the Source Area
- limiting construction in specified areas over the contaminated groundwater that would interfere with the operation of the remedy
- reserving access to the site for monitoring/remediation

4.8.2.1 Source Area LUC Design and Planning

The Army has LUCs for this portion of the plume to include existing zoning and lease terms (1996 Lease of Furtherance of Conveyance) between the Army and Mass Development that address these objectives. Existing zoning in the Source Area includes Special Use II and Innovation and Technology Business which includes; environmental, full and small scale office, light industrial, industrial, research and development, health care, academic/institutional/civic, municipal, small scale retail, group residences, and incubator (as outlined in the November 18, 1994 Devens By-Laws). The 1996 Lease of Furtherance of Conveyance restricts the use of groundwater, limits building construction, and interference of the remedy as outlined in the lease (Appendix B). In addition, restrictions on land-use including; no residential dwellings or schools/child care facilities, no pumping or use of groundwater, modifications to storm water discharge limited to existing municipal infrastructure, no new building construction and Army site access for monitoring/remediation will also be incorporated into the Transfer deed prior to conveyance of the property to Mass Development. Site development activities including soil excavation and modifications to storm water discharge are subject to prior approval and soil management/safety planning.

4.8.2.2 Source Area LUC Implementation and Enforcement

The FOST and transfer deed for the Source Area (Parcel A.5) will incorporate the LUCs in the Environmental Protection Provisions. The transfer documents shall be executed in accordance with all applicable requirements, to include the Army's residual liabilities and responsibilities under CERCLA, as well as the transferee's obligations to maintain and enforce LUCs. The Army remains ultimately responsible for ensuring that remedy Performance Objectives are met, while the transferee will assist the Army to the extent possible and will be responsible for complying with the deed and deed notice.

Following transfer of the property to Mass Development, the Army will work closely with Mass Development and the Devens Enterprise Commission (DEC) to ensure a smooth transfer and continued conformance with the LUCs. The DEC acts as the local regulatory agency within the former Fort Devens and Mass Development acts as the Local Redevelopment Authority. In the event that the DEC is no longer the local land use agency, the Army will coordinate with the new governing entity for all LUC zoning layers that are required to be incorporated into the zoning by-laws.

In order to allow development over the Source Area of the plume and to insure that the objectives of the LUCs are met, a formal review and approval process will be implemented through Mass Development and the DEC (and its successor) in cooperation with the Base Cleanup Team (BCT). The formal process will be incorporated into the DEC regulations.

The formal review process will include an engineering demonstration by the party, that the proposal will protect the integrity and effectiveness of the selected remedy and provide access to maintain the remedy and prevent unacceptable risk for the duration of the remedy. The engineering demonstration will include technical justification commensurate with industry/government standards including Storm water Management Plans and will include a formal presentation before the DEC and BCT. Following the presentation and submission of the technical justification, the DEC and BCT will have 30 days to review the submittal and provide comments and an additional 30 days to approve or deny the request after responses to comments have been received.

These restrictions shall be implemented, monitored, reported on, and enforced by the Army with input from Mass Development and the DEC and shall be maintained until the concentration of hazardous substances in the soil and groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. The Source Area plume and the associated LUC limits are shown on **Figure 3**.

4.8.3 Southwest Plume LUC

The objectives of the LUCs in the Southwest Plume include:

- protecting potential residential and commercial/industrial receptors from ingesting contaminated groundwater
- restricting groundwater pumping and storm water discharge/recharge to avoid drawing the contaminated groundwater away from the limits of the plume
- limiting construction in specified areas over the contaminated groundwater that would interfere with the operation of the remedy
- providing access to the site for monitoring/remediation

4.8.3.1 Southwest Plume LUC Design and Planning

The Army is finalizing legal agreements between the Army, Mass Development, and the US Fish and Wildlife Service as the primary layer of LUCs for this portion of the plume in order to meet the objectives outlined above. Legal agreements between the Army and Mass Development incorporated by the DEC (Parcel 4) and the US Fish and Wildlife Service (Memorandum of Agreement (MOA)) managed as part of the Oxbow Refuge (Parcel 1E) are being finalized. These legal agreements restrict activities that would interfere with the operation of the remedy including the construction of structures, groundwater withdrawal for any purpose, storm water discharge/recharge, and provide for Army access to the properties during the operation of the remedy to install and maintain monitoring wells and treatment systems. The LUC for Parcel 4 will be in the form of a notice to the deed and the LUC for Parcel 1E will be in the form of a MOA. In accordance with the AOC 50 RAWP, LUCs for Parcel H need to be incorporated into the DRFTA "base master plan" if one exists or some other instrument (e.g., MOA) be finalized to restrict activities necessary to protect human health and the environment and the remedy's integrity.

A secondary layer of LUCs will include; Planning Board Reviews, Building Permits, and restricting the potable use of groundwater through public and private well regulations.

4.8.3.2 Southwest Plume LUC Implementation and Enforcement

A formal review and approval process will be implemented through Mass Development and the DEC (and its successor) in cooperation with the BCT in order to allow development over the Mass Development Southwest Plume parcel and to insure that the objectives of the LUCs are met. In the event that the DEC is no longer the local land use agency, the Army will coordinate with the new governing entity for all LUC zoning layers that are required to be incorporated into the zoning by-laws.

The formal process will be incorporated into the DEC regulations. Areas that are restricted and will require a formal review and approval by the BCT, with review by the DEC to insure compliance with the LUCs include; the area overlying the Southwest Plume boundary for building construction and the entire limits of the Southwest Plume LUC Area for storm water discharge/recharge. No groundwater withdrawal or injection will be allowed for any purpose within the entire limits of the Southwest Plume LUC Area until the concentration of hazardous substances in the soil and groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. The Southwest plume and the associated LUC limits are shown on **Figure 3**.

The formal review process will include an engineering demonstration by the party, that the proposal will protect the integrity and effectiveness of the selected remedy and provide access to maintain the remedy and prevent unacceptable risk for the duration of the remedy. The engineering demonstration will include technical justification commensurate with industry/government standards including Storm water Management Plans and hydrologic/mounding studies and will include a formal presentation before the DEC and BCT. Following the presentation and submission of the technical justification, the BCT will have 30 days to review the submittal and provide comments and an additional 30 days to approve or deny the request after responses to comments have been received from the applicant. Presumptive approval will occur after this time period.

The LUC boundaries and restrictions are incorporated in the AOC 50 RAWP which has been distributed to the Devens Repositories and the AOC 50 document distribution list and will be referenced in the MOA with the U.S. Fish & Wildlife Service (Parcel 1E) and in a notice to the deed with Mass Development (Parcel 4). The Army will work closely with Mass Development and the DEC and US Fish and Wildlife Service to ensure conformance with the LUCs. The LUCs for the Southwest Plume will be implemented, monitored, reported on, and enforced by the Army with input from Mass Development and the DEC and the US Fish and Wildlife Service and shall be maintained until the concentration of hazardous substances in the soil and groundwater beneath have been reduced to levels that allow for unlimited exposure and unrestricted use. Any such agreement shall be undertaken and executed in accordance with all applicable CERCLA requirements, to include the Army's residual liability and responsibilities under CERCLA. The Army remains ultimately responsible for remedy integrity. The LUCs will cover the areas shown on **Figure 3**.

5.0 CONCLUSIONS

A multi-component remedy is currently being implemented at AOC 50 for active remediation of PCE in groundwater across the Site. The active remedy currently consists of five ERD treatment areas and an IWS barrier. SVE has also been used in the Source Area, but was approved for decommissioning by the BCT in November 2005.

The ERD technology is currently operating in the Source Area and at four additional transects throughout the PCE plume. As described in this report, the ERD process has been properly constructed, maintained, and operated in accordance with design specifications. Additionally, PCE degradation rates are consistent with the model predictions, comparable degradation trends exist in each of the IRZ areas, and the remedial action goals are expected to be achieved within the targeted timeframe of 23 years.

The IWS system was also properly constructed, maintained, and operated as designed and is meeting its remedial action goals of lowering PCE concentrations and developing an aerobic zone in the groundwater. Since start-up, the system has removed 25 pounds of PCE from extracted groundwater, which corresponds to approximately 90% of the PCE in the IWS area. In addition, degradation byproducts (cis-1,2-DCE, VC) from the upgradient ERD areas are intercepted and oxidized at this aerobic barrier.

PCE concentrations in groundwater for the North Plume, are below the MCL of 5 ppb and were less than the laboratory detection limit of 2 ppb in June and September 2006.

Land-use control agreements have been prepared and are currently in place through an agreement with the North Plume property owner, through lease restrictions in the Source Area, and an MOA with the U.S. Fish & Wildlife Service in the Southwest Plume. In addition a Notice of Land Use Controls is being finalized with Mass Development for the Southwest Plume.

As demonstrated in this report, the proper and successful operation, maintenance, and monitoring of this multi-component remedy is in place and well established, and will continue in accordance with the accepted design and remedial goals. In addition, the AOC 50 LTM and O&M Plans will be revised as necessary to provide the requisite amount and quality of data to demonstrate that the site conceptual model continues to be valid and that remedy performance continues to meet ROD performance objectives.

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Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

			Laboratory Parameters																	Field Parameters					
Area of Concern	Well ID	Date	PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
North Plume	G6M-96-22A	10/16/2001	2U	2U	2U	2U	1U	2U												5.5	5.1	210	2	0	12.6
	G6M-96-22A	2/28/2002	2U	2U	2U	2U	1U	2U			0.10U									5.7	8.37	183.5	1.78	0.5	9.54
	G6M-96-22A	9/21/2004	2U	2U	2U	2U	1U	2U						5U	1U	54				5.75	6.73	187.9	1.885	1.59	13.42
	G6M-96-22A	9/29/2005	2U	2U	2U	2U	1U	2U						5U	1U	52				5.95	4.9	223.1	3.18	0.38	14.15
	G6M-96-22A	9/20/2006	2U	2U	2U	2U	1U	2U						5U	0.10U	42				5.68	4.78	176.3	1.814	1.85	14.3
North Plume	G6M-96-22B	10/19/2001	2U	2U	2U	2U	1U	2U												6.76	6.95	176	2.09	0.6	12.51
	G6M-96-22B	2/28/2002	2U	2U	2U	2U	1U	2U			0.10U									6.35	7.83	198.5	2.002	1.5	10.08
	G6M-96-22B	1/31/2003	2U	2U	2U	2U	1U	2U																	
	G6M-96-22B	9/21/2004	2U	2U	2U	2U	1U	2U						5U	1U	44				5.83	6.15	193.9	1.941	2.76	13.5
	G6M-96-22B	9/29/2005	2U	2U	2U	2U	1U	2U						5U	1U	48				6.12	5.57	187.7	3.02	1.43	16.38
	G6M-96-22B	9/20/2006	2U	2U	2U	2U	1U	2U						5U	0.10U	44				5.53	6.51	179	2.183	0.67	15.13
North Plume	G6M-96-24B	10/16/2001	18	2U	2U	2U	1U	2U												6.37	0	81	0.42	19	12.96
	G6M-96-24B	3/1/2002	11	2U	2U	2U	1U	2U												6.35	-6.27	106.7	0.43	2.8	10.53
	G6M-96-24B	1/31/2003	7.5	2U	2U	2U	1U	2U																	
	G6M-96-24B	1/12/2004	11	2U	2U	2U	1U	2U																	
	G6M-96-24B	9/24/2004	13B	2U	2U	2U	1U	2U												6.17	0.2	152.2	0.422	0.44	12.34
	G6M-96-24B	12/17/2004	8.1	2U	2U	2U	1U	2U												6.05	0.46	259.6	0.384	2.43	11.49
	G6M-96-24B	4/13/2005	8.2	1U	2.8	1U	1U	1U												5.32	0.2	216.6	0.429	2.49	10.82
	G6M-96-24B	7/6/2005	7.6	2U	3	2U	1U	2U												5.69	1.34	242.8	0.77	0.02	16.85
	G6M-96-24B	9/30/2005	7.2	2U	3.6	2U	1U	2U												5.77	0.29	198.3	1.022	7.7	10.87
	G6M-96-24B	12/15/2005	7.4	2U	3.1	2U	1U	2U												5.97	0.14	242.8	0.9	2.1	9.71
	G6M-96-24B	3/23/2006	4.2	2U	2U	2U	1U	2U												5.99	0.23	404.5	0.458	1.31	10.91
	G6M-96-24B	6/23/2006	2U	2U	2U	2U	1U	2U												4.62	0.85	526.9	0.443	0.88	15.95
	G6M-96-24B	9/22/2006	2U	2U	2U	2U	1U	2U												5.93	0.3	141	0.407	4.23	12.41
FDW	G6M-02-08X	5/17/2002	2300	35	250	2U	1U	5.8																	
	G6M-02-08X	1/31/2003	3600	46	480	2.3	1U	2.2																	
	G6M-02-08X	3/31/2005	1300	38J	250	50U	50U	50U	15	61.5	1.1	6.2	2U	5U	0.3J	770	49	790	1.2	7.08	9.1	-50	0.563	24.6	11.44
	G6M-02-08X	7/5/2005	1000	130	1800	12U	12U	12U	450	350	0.05U	3.7	8.3	33	110	29000	160	220	3	4.23	1.66	19.1	1.616	4.72	15.95
	G6M-02-08X	9/27/2005	560	26	1300	1U	1.8	2.5	1200	466	0.05U	320J	16	270	310J	75U	110	250	21	5.03	0.33	-68.6	1.965	3.16	13.04
	G6M-02-08X	12/16/2005	300	24	1200	4U	2U	4U	1500	520	0.5U	57	9.4	5U	350	15U	190	360	2.1	5.46	0.03	-31.4	1.999	66.4	7.91
	G6M-02-08X	3/21/2006	180	25	1300	2U	2.1	2.3	3000	1400	1U	245	14	80	470	40000	84	240	15	5.46	0.33	-62.5	2.45	6.98	9.64
	G6M-02-08X	6/21/2006	230	30	850	2U	1U	2U	5700	1800	1.67	759	40	100	970	44000	140	230	19	4.8	1.32	-25.2	4.528	45.4	14.95
	G6M-02-08X	9/20/2006	150	25	1300	2U	1.6	2U	4400	1000	2U	655	16	77	860	29000	72	140	11	5.2	1.57	-14.4	4.503	53.4	18.79
FDW	G6M-03-02X	5/12/2003	1300	2U	4.4	2U	1U	2U																	
	G6M-03-02X	10/11/2004	690	2U	5.6	2U	1U	2U	1U	12	3.7	20	1.7J	5U	1U	17	51	30	2.6	6.29	8.25	97.4	0.321	12.1	14.82
	G6M-03-02X	12/15/2004	200	2U	5	2U	1U	2U	390	29	2.4	30	2U	5U	1U	610	56	63	3.4	5.86	1.75	-132.9	0.382	1.93	8.4
	G6M-03-02X	3/29/2005	340	20U	14J	20U	10U	20U	1300	366	0.2U	230	6.7J*	640	140M	49000	150	340	5.1	5.23	0.65	-20.1	1.654	28.7	11.99
	G6M-03-02X	6/29/2005	190	11	91	2.5U	2.5U	2.5U	1200	431	0.05U	74	11	130	220J*	35000J*	290	650	43	4.62	1.13	2.9	1.723	29.1	20.17
	G6M-03-02X	9/29/2005	57	7.8	190	2.5U	2.5U	2.5U	850	345	0.05U	62	16	150	260J	37000	200	290	560	4.94	0.53	-73.7	1.752	23.8	16.73
	G6M-03-02X	12/15/2005	39	8U	190	8U	4U	8U	1100	550	0.05U	66	16	146	290	38000	170	260	4300	5.42	4.55	13.9	1.65	19.7	9.6
	G6M-03-02X	3/21/2006	17	2U	140	2U	1U	2U	1400	1200	2U	88.4	8.8	140	320	37000	16J	140	6700	5.56	0.16	-47.7	1.731	17.3	13.27
	G6M-03-02X	6/21/2006	8.2	2U	160	2U	1U	2U	1300	1000	1U	120	9.6	240	410	23000	44	120	10000	3.21	0.89	140.1	2.428	11.6	18.8
	G6M-03-02X	9/20/2006	9.7	2.3	230	2U	1U	2U	1300	570	1U	115	8.4	200	440	21000	50	200	8700	5.55	0.71	-27.8	2.029	13.7	13.92
FDW	G6M-04-11X	9/20/2004	8.5	2U	2U	2U	1U	2U												6.54	3.42	374.7	0.782	16.8	16.22
	G6M-04-11X	9/26/2005	7.8	2U	2U	2U	1U	2U												6.96	5.14	94.6	0.39	8.7	13.05
	G6M-04-11X	9/20/2006	4	2U	2U	2U	1U	2U												6.24	6	129	0.38	5.99	17.5
FDW	G6M-04-12X	9/20/2004	310	7.5	56	2U	1U	2U						5U*	1	44				11.03	0.86	102.6	2.003	5.22	15.88
	G6M-04-12X	9/26/2005	250	6.8	49	2U	1U	2U						15	1U	360				8.41	1.05	234.2	1.961	1.65	14.25
	G6M-04-12X	9/18/2006	470	9.4	60	2U	1U	2U						6.5	0.10U	550				7.21	3.22	253.5	1.764	7.11	14.5

Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

Area of Concern	Well ID	Date	Laboratory Parameters																	Field Parameters					
			PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
FDW	G6M-93-13X	10/15/2001	0.55J	2U	2U	2U	1U	2U												5.3	9.9	355	6	1.2	14.5
	G6M-93-13X	9/20/2004	3.8	2U	2U	2U	1U	2U	1U	23	1.3J*	10	2.7J*	5U	1	15U	8.1	14	0.89	6.14	13.07	250.7	0.059	4.31	16.26
	G6M-93-13X	12/13/2004	2U	2U	2U	2U	1U	2U	5U	20	1.2	9.6M	2U	5U	1U	15U	5U	5U	3.8	6.16	10.41	192.5	0.08	1.42	12.95
	G6M-93-13X	3/29/2005	2U	2U	2U	2U	1U	2U	0.6J	22.0	0.2U	9.1	2U	5U	1UM	15U	6.3	280	3.1	6.24	10.4	97.3	0.09	0.64	10.89
	G6M-93-13X	6/28/2005	2U	2U	2U	2U	1U	2U	4.9	41.2	0.081	8.2	1U	2U	1U	10U	23	20	9.4	11.3	11.43	146.1	0.275	2.46	19.81
	G6M-93-13X	9/26/2005	2U	2U	2U	2U	1U	2U	3.1	27.0	0.083	9.5	1U	5U	1U	15U	6J	18J	4.9	6.04	7.98	191.8	0.126	18.2	20.19
	G6M-93-13X	12/13/2005	2U	2U	2U	2U	1U	2U	4.4J	41	3.4	9.4	1U	5U	1U	15U	8J	11J	9.3	6.48	9.55	69.6	0.086	0.5	9.22
	G6M-93-13X	3/21/2006	2U	2U	2U	2U	1U	2U	6.8	24	0.2U	6.83	1U	5U	0.1U	19	25U	46	9.5	6.87	9.55	-9.4	0.058	0.61	7.38
	G6M-93-13X	6/19/2006	2U	2U	2U	2U	1U	2U	1.4J	46	0.2UH	4.42	1U	5U	0.1U	28	8J	8J	5.3	6.33	9.14	190.1	0.087	1.34	15.55
	G6M-93-13X	9/18/2006	2U	2U	2U	2U	1U	2U	4.6J	22	0.2U	7.76	1U	5U	0.10U	15U	6J	14J	5	6.22	9.33	173.6	0.062	4.62	16.43
FDW	G6M-95-19X	10/15/2001	110	6.6	42	1.5J	1U	2U												5.46	6.24	202	2.87	8.5	14.8
	G6M-95-19X	9/20/2004	41	2.9	16	2U	1U	2U						5U	1	210				5.45	7.92	467.5	4.17	3.1	15.91
	G6M-95-19X	9/26/2005	21	2U	5.4	2U	1U	2U						8.3	1U	160				4	4.51	595.3	4.361	0.72	13.31
	G6M-95-19X	9/19/2006	12	2U	2U	2U	1U	2U						5U	0.10U	160				3.82	6.77	281	4.236	2.41	15.19
FDW	G6M-96-13B	10/15/2001	3600	39	220	12	1U	1.1J												6.1	2.9	219	0.12	6.8	12.4
	G6M-96-13B	2/25/2002	5200	34	200	1.4J	1U	1.5J												6.4	3.85	181.5	1.142	6.59	10.96
	G6M-96-13B	1/31/2003	3800	31	190	2U	1U	2U																	
	G6M-96-13B	9/20/2004	4500	35	210	2U	1U	2.1	1U	38	5.4J*	19	2	5U	1	15U	22	120	1.7	6.3	3.57	186.4	1.035	0.5	12.7
	G6M-96-13B	12/13/2004	2500	24	150	2U	1U	2U	5U	35	5	31M	2U	5U	1U	23	50	25	24	6.26	2.57	316.5	0.787	2.68	11.05
	G6M-96-13B	3/28/2005	4500	200U	180J	200U	200U	200U	5.7	47	0.46	17	2UJ*	5U	2.6M	1600	170	220	37	6.24	0.87	21.2	0.943	0.68	10.67
	G6M-96-13B	8/10/2005	2800	190	1500	3.6	4.8	6.8	140	98.9	0.23	4.6	5.3	32	24J*	8100	150	440	2.9	4.35	0.16	-35.6	0.838	3.5	14.53
	G6M-96-13B	9/26/2005	3700	140	570	5U	5U	5U	200	134	0.28	11	11	44	51J	12000	54	330	18	4.98	1.32	-45.9	1.071	4.54	13.39
	G6M-96-13B	12/13/2005	3400	130	350	10U	5U	10U	140	150	0.05U	11	4.5	46.3	63	12100	69	350	31	5.51	0.13	-52.1	0.851	0.9	10.65
	G6M-96-13B	3/20/2006	2100	250	400	2U	1.2	2.5	360	300	0.207	6.77	2.4	38	96	17000	36	420	97	5.68	0.17	-161.5	0.759	7.1	9.84
	G6M-96-13B	6/20/2006	1900	280	370	2U	1U	3.5	110	310	0.2U	4.21	4.8	48	100	16000	44	270	200	5.46	0.62	-86.8	1.252	2.63	14.08
	G6M-96-13B	9/18/2006	880	370	530	2U	1.3	9.4	300	370	0.262	4.56	3	150	110	20000	22J	430	2400	6.14	0.48	-120.9	1.555	2.19	14.45
FDW	G6M-96-25B	10/15/2001	360	2U	2U	2U	1U	2U												5.81	5.3	142	0.498	3.9	14.55
	G6M-96-25B	2/25/2002	130	2U	2U	2U	1U	2U												6.7	11.51	158.5	0.15	9.75	11.1
	G6M-96-25B	2/27/2002									7.2														
	G6M-96-25B	1/31/2003	52	2U	2U	2U	1U	2U																	
	G6M-96-25B	9/20/2004	56	2U	2U	2U	1U	2U												4.98	7.63	593	0.589	0	13.13
	G6M-96-25B	9/26/2005	40	2U	2U	2U	1U	2U												5.82	6.74	314.1	0.587	1.1	12.89
	G6M-96-25B	9/19/2006	44	2U	2U	2U	1U	2U												5.2	7.64	223.5	0.496	1.46	13.48
FDSA	G6M-04-09X	9/24/2004	7400	4.2	9	2U	1U	2U						5U	1UJ	160				5.15	3.84	637.6	0.495	0.82	17.2
	G6M-04-09X	9/28/2005	3200	5U	5U	5U	5U	5U						5U	1U	37				5.92	3.41	678.4	0.169	2.07	15.42
	G6M-04-09X	9/21/2006	190	2U	2U	2U	1U	2U						5U	0.10U	50				5.83	8.18	215.6	0.102	5.51	13.18
FDSA	G6M-04-10A	9/20/2004	2900	2.5	3.4	2U	1U	2U	1U	41	4.5J*	22	2	5U	1	170	21	30	1.1	5.91	3.75	206.5	0.552	1.7	13.59
	G6M-04-10A	12/14/2004	2400	2U	2U	2U	1U	2U	5U	25	1.7	13	2U	5U	1U	120	15	96	1500	5.89	2.81	215.4	0.965	2.04	8.84
	G6M-04-10A	3/30/2005	640	40U	40U	40U	40U	40U	52	107	0.33	16	2U	8.4	1.2	8100	330	70	1.4	5.9	4.22	68.3	1.01	1.76	10.62
	G6M-04-10A	8/11/2005	380	45	390	2U	2U	2U	240	359	.05U	7.8	1U	77	87J*	50000J*	240	230	3.4	5.65	1.84	11.9	0.977	14.9	19.56
	G6M-04-10A	9/27/2005	340	88	260	1U	1U	1U	330	442	0.084	3.0J	5.9	190	230J	76000	80	150	110	6.33	1.89	-1.9	1.135	4.3	15.68
	G6M-04-10A	12/14/2005	1500	180	220	2U	2U	2U	370	480	<0.050	3.7	7.4	179	250	32500	48	130	6800	6.41	1.57	-64.8	0.985	1.9	9.54
	G6M-04-10A	3/21/2006	4400	180	450	2U	1U	8.3	180	390	0.2U	4.08	2	180	220	8100	25U	690	20000	6.72	0.27	-121.4	0.676	7.51	10.21
	G6M-04-10A	6/20/2006	6100	650	330	2U	1U	27	120	340	0.2U	4.32	3.2	160	220	5700	25U	120	16000	6.34	0.22	-99.8	0.893	9.82	15.4
	G6M-04-10A	9/19/2006	1000	15	59	2U	1U	14	61	150	0.311	5.2	1.2	170	97	5000	230	110	11000	6.56	1.14	-86.9	0.43	6	14
FDSA	G6M-04-10X	9/20/2004	70	7.5	32	2U	1U	2U	1U	11	6.7J*	21	3.4	5U	1	260	19	39	1	5.59	6.87	246.2	0.902	0.95	14.64
	G6M-04-10X	12/14/2004	65	7.8	35	2U	1U	2U	5U	10U	6.6	23	2U	5U	1U	200	22	53	2.2	5.4	7.57	424.2	0.816	5.5	6.31
	G6M-04-10X	3/31/2005	56	6.8	30	2U	2U	2U	0.4J	10U	1.5	25	2U	5U	1U	190	22	860	1.1	5.18	7.65	256.7	1.337	0.41	11.18
	G6M-04-10X	7/1/2005	50	5.4	23	2U	1U	2U	5.9	43.5	1.7	12	1U	4.2	1UJ*	10U	35	50	12	5.33	6.09	265.2	1.502	0.9	15.77
	G6M-04-10X	9/27/2005	48	4.7	23	2U	1U	2U	4	7.7	1.4	26	1U	5U	1U	170	10J	18J	16	5.26	6.68	450.9	1.123	0.5	13.97
	G6M-04-10X	12/14/2005	67	6.3	27	2U	1U	2U	5U	9.8	1.5	28	1U	5U	1U	164	16J	34	11	5.49	6.78	205.1	1.032	3.4	10.09
	G6M-04-10X	3/22/2006	76	9.1	32	2U	1U	2U	5.6	10U	1.44	23.6	1U	5U	0.1U	200	15J	25J	25	5.57	6.74	195.7	0.94	1.45	9.82
	G6M-04-10X	6/20/2006	87	10	47	2U	1U	2U	5U	10U	1.69	25.2	1U	5U	0.1U	240	13J	12J	18	5.08	6.23	248.8	1.512	1.9	15.25
	G6M-04-10X	9/19/2006	65	6.8	32	2U	1U	2U	2.2J	8	1.27	22.2	1U	5U	0.10U	240	26	25J	13	5.21	6.94	273.9	1.66	4.68	14.25
FDSA	G6M-04-13X	9/21/2004	8	2U	2U	2U	1U	2U						5U	1U	350				5.96	8	551.8	0.138	1.75	14.39
	G6M-04-13X	9/26/2005	2U	2U	2U	2U	1U	2U						5U	1U	15U				6.43	10.5	180	0.042	3.8	10.63
	G6M-04-13X	9/18/2006	2U	2U	2U	2U	1U	2U						5U	0.10U	15U				5.65	8.63	213.9	0.076	12.1	14.35

Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

			Laboratory Parameters																	Field Parameters					
Area of Concern	Well ID	Date	PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
FDSA	G6M-04-15X	9/21/2004	5.2	2U	5.3	2U	1U	2U						5U*	4.8	8100				5.26	0.82	410	2.64	0.23	14.4
	G6M-04-15X	9/28/2005	9.1	2U	6.4	2U	1U	2U						33	1.8	4400				5.11	0.39	248.1	0.674	0.29	16.01
	G6M-04-15X	9/20/2006	3.5	2U	5.2	2U	1U	2U						20	2	4300				4.6	1.07	-100.3	1.555	0.95	17.24
FDSA	G6M-94-18X	10/16/2001	2U	2U	2U	2U	1U	2U												5.2	8.4	291	7	6.4	12.6
	G6M-94-18X	2/25/2002	6400	2U	2U	2U	1U	2U																	
	G6M-94-18X	2/27/2002	2800								0.91									6.11	8.9	147	0.086	45.3	12.07
	G6M-94-18X	2/4/2003	37000	2U	2U	2U	1U	2U																	
	G6M-94-18X	9/20/2004	3400	2U	2U	2U	1U	2U	1U	18	2	11	4	5U	1	15U	11	22	1.1	6.15	9.03	321.7	0.078	3.8	13.89
	G6M-94-18X	12/15/2004	2300	2U	2U	2U	1U	2U	5U	110	1.6	10	2U	5U	1U	15U	5U	8.5	9.1	6	9.36	441	0.062	64.7	11.35
	G6M-94-18X	3/31/2005	17000	1000U	1000U	1000U	1000U	1000U	1.1J	14.4	0.23	10	2U	5U	1U	15U	11	710	0.97	6.17	10.34	171.9	0.063	16.6	11.34
	G6M-94-18X	7/1/2005	2000	2.5U	2.5U	2.5U	2.5U	2.5U	4.7J	14	0.13	9.2	1U	2U	1UJ*	10U	51	25	2.7	5.77	8.03	247.9	0.083	21.3	18.31
	G6M-94-18X	9/27/2005	710	1U	1U	1U	1U	1U	3.8	15.4	0.071	8.8J	1U	5U	1U	15U	32	40	0.48	5.72	8.82	228.1	0.054	6	13.78
	G6M-94-18X	12/16/2005	260	2U	2U	2U	1U	2U	6	10	0.068	14	1U	5U	1U	15U	42	150	0.17	6.21	8.74	188.5	0.096	98.3	11.23
	G6M-94-18X	3/21/2006	66	2U	2U	2U	1U	2U	5.5	12	0.2U	14.6	1U	5U	0.16	15U	25U	16J	23	6.39	10.48	440.4	0.078	188	10.81
	G6M-94-18X	6/20/2006	46	2U	2U	2U	1U	2U	1.6J	25	0.2U	11.3	1U	5U	0.1U	15U	4J	8J	6.5	5.43	7.18	1022.5	0.073	5.43	19.03
	G6M-94-18X	9/18/2006	41	2U	2U	2U	1U	2U	4.9J	15	0.2U	9.66	1U	5U	0.10U	15U	6J	21J	19	5.84	7.15	204.3	0.111	18.2	18.31
FDSA	G6M-95-20X	10/16/2001	4.4	2U	2U	2U	1U	2U												5.9	7.2	212	0.27	4.1	16
	G6M-95-20X	2/25/2002	5	2U	2U	2U	1U	2U												6.59	12.37	155.7	0.171	7.67	15.24
	G6M-95-20X	2/27/2002									4.7														
	G6M-95-20X	9/21/2004	2.8	2U	2U	2U	1U	2U						5U	1U	15U				5.76	8.88	205.5	0.544	0	15.69
	G6M-95-20X	9/26/2005	2.3	2U	2U	2U	1U	2U						5U	1U	15U				5.62	8.75	328.7	0.741	0.95	15.22
	G6M-95-20X	9/19/2006	2.2	2U	42	2U	1U	2U						71	350	39000				6.31	0.76	-108	2.715	4.19	17.33
Area 1	G6M-04-22X	9/21/2004	900	24	110	2U	1U	2U						5U	1U	990				6.3	4.78	192.2	0.897	19	15.24
	G6M-04-22X	9/28/2005	210	6.8	45	2.5	1U	2U						5U	1U	120				5.52	6.13	391.3	0.757	21	14.69
	G6M-04-22X	9/20/2006	200	8.7	54	2U	1U	2U						5U	0.43	4500				5.68	2.8	197.8	1.048	6.98	14.3
Area 1	G6M-04-31X	9/21/2004	1600	2U	4.2	2U	1U	2U						5U	1U	190				5.69	5.1	211	1	2.99	16.33
	G6M-04-31X	9/28/2005	1900	5U	5.2	5U	5U	5U						5U	1U	35				5.63	3.66	305.4	0.388	2.2	15.03
	G6M-04-31X	9/20/2006	600	6.1	2.5	2U	1U	2U						5U	0.10U	15U				6.52	0.28	-108.5	0.729	3.56	15.56
Area 2	G6M-02-01X	2/28/2002	11	2U	2U	2U	1U	2U												6.91	4.7	66.6	0.624	14	13.53
	G6M-02-01X	9/23/2004	24B	2U	2U	2U	1U	2U												6.64	2.54	145	0.784	6.11	19.41
	G6M-02-01X	9/30/2005	110	2U	3.1	2U	1U	2U												6.07	3.82	384.8	0.555	10.9	18.04
	G6M-02-01X	9/20/2006	1300	12	91	2U	1U	2U												6.19	3.68	-108.2	0.708	9.07	17.33
Area 2	G6M-04-01X	9/23/2004	250B	3.6	21	2U	1U	2U						5U	1U	220				6.82	3.92	245.2	2.391	9.42	18.11
	G6M-04-01X	9/28/2005	140	2U	9.2	2U	1U	2U						5.1	1U	170				6.49	5.85	202.3	2.699	7.29	18.59
	G6M-04-01X	9/20/2006	150	2U	7.2	2U	1U	2U						5U	0.10U	220				5.87	4.88	-91.4	2.92	3.53	19.1
Area 2	G6M-04-03X	9/23/2004	440	2U	3.3	2U	1U	2U	1.4	53	5.1	23	2.2	5U	1U	3100	220	36	100	6.37	3.41	446.5	1.236	12.2	18.36
	G6M-04-03X	9/27/2005	680	14	10	1U	1U	1U	6	81.5	0.35	38J	1U	5U	0.6J	3500	190	320	52	6.29	0.79	377.5	1.361	9.62	17.15
	G6M-04-03X	9/22/2006	2600	420	6.3	2U	1U	2U	7.2	190	0.2U	16.6	1U	5U	0.10U	2900	49	300	17	6.3	0.43	152.1	0.524	3.52	15.3
Area 2	G6M-97-08B	10/18/2001	92	6.1	36	1.6J	1U	2U												5.6	4.8	224	0.13	18	15
	G6M-97-08B	2/26/2002	100	5.9	32	2U	1U	2U												5.87	5.13	186.4	1.157	5.3	14.44
	G6M-97-08B	9/22/2004	220	9.3	41	2U	1U	2U	1U	10U	6.1	12	1.5J	5U	1U	26	7.5	5U	1.3	5.69	4.66	252.8	1.516	18.3	17.01
	G6M-97-08B	12/16/2004	200	7.7	41	2U	1U	2U	5U	10U	6.1	12	5.4	5U	1U	25	130	72	0.92	5.79	8.78	165	1.633	3.81	13.61
	G6M-97-08B	3/30/2005	95	3.4J	16	4U	2U	4U	0.4J	12	0.80	7	2U	5U	1U	21	15	32	0.54	5.58	8.06	202.8	0.999	9.42	14.41
	G6M-97-08B	6/28/2005	140	8	36	1.4	1U	2U	7.1	16.7	1.4	12	1U	2U	1J	27	16	41	35	11.3	4.94	173.7	1.506	8.16	19.31
	G6M-97-08B	9/27/2005	180	7.5	42	2U	1U	2U	4.4	15.9	1.3	16	1U	5U	1U	33	13J	27	0.39	5.6	5.73	319.2	1.713	2.82	15.12
	G6M-97-08B	12/12/2005	120	5.7	27	2U	1U	2U	5U	23	0.05U	13	1U	5U	1U	28.1	40	110	26	5.87	4.19	171.1	1.11	0.7	10.84
	G6M-97-08B	3/23/2006	240	8.8	44	2U	1U	2U	5U	13	1.25	13.7	1U	5U	0.1U	46	22J	130	12	5.85	5.13	181.5	1.44	3.16	14.12
	G6M-97-08B	6/21/2006	220	11	35	2U	1U	2U	16	66	0.809	13.5	1	5U	0.17	1300	19J	86	24	5.9	2.39	141.1	2.015	1.48	16.26
	G6M-97-08B	9/19/2006	190	14	55	2U	1U	2U	270	300	0.2U	23.6	2.8	130	21	13000	78	130	18	5.79	1.58	47.6	2.287	4.58	19.14

Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

Area of Concern	Well ID	Date	Laboratory Parameters																	Field Parameters					
			PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
Area 3	G6M-03-07X	5/12/2003	1200	7.2	34	2U	1U	2U																	
	G6M-03-07X	9/24/2004	1700	6.3	31	2U	1U	2U	1U	10U	4.3J*	12	1.6J	5U	1UJ*	20	35	280	5.7	5.77	7	168.3	0.341	84.6	18.13
	G6M-03-07X	12/16/2004	1500	6	35	2U	1U	2U	5U	10U	4.2	12	2.9	5U	1U	190	26	80	0.39	6.02	17.09	321.7	0.348	8.46	13.03
	G6M-03-07X	3/30/2005	1100	91	140	40U	20U	40U	29	76	0.33	8	2U	18	18	10000	78	210	1.8	6.33	1.9	-54.6	0.671	0.7	16.73
	G6M-03-07X	6/29/2005	940	78	940	40U	20U	40U	83	118	0.079	6.4	1U	31	39J*	15000J*	60	340	3.9	11.97	1.12	-20.1	0.915	5.93	23.98
	G6M-03-07X	9/29/2005	300	44	1000	2.3	2.7	1U	290	307	0.05U	3.2	12	46	210J	30000	68	450	660	6.2	2.7	-62	1.266	7.68	17.97
	G6M-03-07X	12/12/2005	92	22	710	20U	10U	20U	220	320	0.05U	2U	6.2	96.1	190	46600	78	130	13000	6.5	0.22	-82.1	1.038	3.6	10.2
	G6M-03-07X	3/24/2006	110	23	430	2U	2	270	260	590	0.2U	1	8.6	130	280	48000	10J	2000	22000	6.87	0.17	-130.5	1.39	10.1	13.1
	G6M-03-07X	6/21/2006	9.5	3.6	180	2U	1U	310	280	570	0.2U	1U	4.8	140MSA	460	59000	73	21000	21000	5.13	0.7	-170.4	2.258	31.4	19.6
	G6M-03-07X	9/19/2006	47	7.9	260	2U	1U	300	290	460	0.926	1.27	5	140	470	44000	37	9200	25000	6.48	0.27	-147.2	2.15	15.1	22.98
Area 3	G6M-04-02X	9/23/2004	1900	2U	3.8	2U	1U	2U						5U	1U	86				6.59	7.25	152.4	0.704	9.52	22.11
	G6M-04-02X	9/28/2005	1800	5U	5U	5U	5U	5U						5U	1U	15U				5.21	6.54	294	0.607	12	19.6
	G6M-04-02X	9/20/2006	1100	170	2.2	2U	1U	2U						5U	0.10U	24				5.22	2.88	-101.5	0.696	10.61	19.32
Area 3	G6M-04-04X	9/24/2004	2300	7.8	24	2U	1U	2U	1U	10U	5.5	20	2U	5U	1UJ*	560	37	120	13	5.75	5.05	197.3	1.637	169	15.8
	G6M-04-04X	9/29/2005	1600	5.4	15	2.5U	2.5U	2.5U	0.5J	5.3	1.4	23	1U	5U	1U	430	18J	60	0.44	5.34	5.66	295.9	1.666	7.39	18.26
	G6M-04-04X	9/19/2006	1600	45	260	2U	1U	2U	120	190	0.2U	10.2	1.6	110	84	31000	120	95	33	6.22	0.32	-71.5	1.765	7.64	19.03
Area 4	G6M-02-03X	2/26/2002	210	2U	2U	2U	1U	2U												11.61	2.21	11	1.154	18.1	16.08
	G6M-02-03X	9/23/2004	48	2U	2U	2U	1U	2U												4.95	1.17	632.1	1.374	3.8	18.88
	G6M-02-03X	9/29/2005	12	2U	2U	2U	1U	2U												5.7	2.9	204.9	1.138	10.67	17.6
	G6M-02-03X	9/18/2006	10	2U	2U	2U	1U	2U												5.2	0.35	219.4	0.993	4.32	17.62
Area 4	G6M-02-04X	2/26/2002	470	0.88J	1.3J	2U	1U	2U												6.47	3.4	189.5	0.26	24	14.39
	G6M-02-04X	9/23/2004	170B	2U	2.9	2U	1U	2U						5U	1U	15U				6.29	3.03	175.5	0.453	8.48	17.99
	G6M-02-04X	9/28/2005	150	2U	6.2	2U	1U	2U						5U	1U	15U				5.61	2.75	302.3	0.502	12.6	19.59
	G6M-02-04X	9/20/2006	48	2U	2U	2U	1U	2U						5U	0.10U	15U				5.84	4.57	189	0.467	8.45	17.26
Area 4	G6M-02-13X	8/2/2002	4600	4	2U	2U	1U	2U						5U						6.17	0.54	141	0.665	7.62	19.7
	G6M-02-13X	9/23/2004	5000	13	16	2U	1U	2U	1U	31	2.3	17	1.8J	5U	1U	1200	270	150	57	6.37	0.34	170.8	0.618	2.14	17.11
	G6M-02-13X	12/13/2004	4600	14	21	2U	1U	2U	5U	34	2.5	16M	2U	5U	1U	1300	270	110	88	5.79	0.89	274.8	0.518	2.63	13.11
	G6M-02-13X	3/30/2005	2100	64J	210	100U	50U	100U	8.1	60	0.23	13	2U	36	4.2	4000	160	110	38	5.97	0.89	-22.6	0.735	2.91	14.37
	G6M-02-13X	8/11/2005	2300	190	460	5.9	2U	2U	66	230	0.05U	2.3	1U	150	34J*	12000J*	26	45	46	5.82	0.74	-68.8	0.897	5.6	21.32
	G6M-02-13X	9/29/2005	3700	120	470	10U	10U	10U	37	110	0.05U	8.9	2.4	74	22	6800	160	120	420	6.41	1.26	-89.1	0.71	6.99	15.51
	G6M-02-13X	12/14/2005	210	50	850	2U	2	2U	290	420	0.083	2U	8.2	477	200	36200	57	87	11,000	6.6	0.11	-134.4	1.389	0.6	13.71
	G6M-02-13X	3/22/2006	660	37	640	2U	1U	2U	280	480	0.2U	8.08	3	320	170	29000	25U	9J	21000	6.67	0.9	-214.4	1.379	2.37	13.98
	G6M-02-13X	6/22/2006	160	8.8	440	2U	1U	280	140	480	0.2U	1.15	20	750	420	30000	25J	510	25000	6.54	0.28	-138.7	2.175	16.1	16.73
	G6M-02-13X	9/18/2006	550	52	160	2U	1U	280	52	140	0.2U	8.09	2.8	420	160	9900	150	1100	24000	6.12	0.36	-119.3	1.19	6.9	18.3
Area 5	G6M-02-05X	2/28/2002	130	2U	1.9J	2U	1U	2U												6.15	6.61	181.1	0.597	11	13.1
	G6M-02-05X	1/30/2003	170	2U	2.3	2U	1U	2U																	
	G6M-02-05X	9/30/2005	200	2U	2.6	2U	1U	2U												4.73	3.61	441.8	0.512	7.9	15.72
	G6M-02-05X	9/22/2006	350	2U	2.2	2U	1U	2U												5.52	2.14	94.8	0.543	7.38	16.65
Area 5	G6M-02-06X	3/1/2002	2U	2U	2U	2U	1U	2U												7.16	8.91	134.8	0.135	32	11.16
	G6M-02-06X	9/24/2004	5.5B	2U	2U	2U	1U	2U												7.33	9.48	152.8	0.09	0.02	14.01
	G6M-02-06X	9/30/2005	2U	2U	2U	2U	1U	2U												7.22	8.22	66.4	0.107	4.39	12.18
	G6M-02-06X	9/21/2006	2U	2U	2U	2U	1U	2U												7.3	7.84	139.3	0.098	10.85	12.31
Area 5	G6M-02-07X	2/26/2002	24	2U	2U	2U	1U	2U												7.34	-0.68	110.3	0.259	46	12.86
	G6M-02-07X	9/23/2004	26B	2U	2U	2U	1U	2U												7.26	1.72	332.8	0.423	25	13.93
	G6M-02-07X	9/30/2005	16	2U	2U	2U	1U	2U												7.69	6.98	121.2	0.389	7.7	12.89
	G6M-02-07X	9/21/2006	11	2U	2U	2U	1U	2U												7.58	3.72	143.6	0.251	14.3	11.54

Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

			Laboratory Parameters																	Field Parameters					
Area of Concern	Well ID	Date	PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
Area 5	G6M-02-11X	8/1/2002	450	2.8	2U	2U	1U	2U						5U						6.01	0.46	184	0.984	8.13	16.6
	G6M-02-11X	8/28/2002	540J	2U	2U	2U	1U	2U	5U	44				5U						6.05	0.51	173	0.905	6.49	15
	G6M-02-11X	10/29/2002	970	22	3	2U	1U	2U	5U	51	0.10U	17	2.0U	5U	1U	1700				6.02	0.49	51	0.92	5.04	12.1
	G6M-02-11X	2/3/2003	710	22	2U	20U	1U	2U	5U	65				5U	1U					6.22	0.71	178	0.971	12.7	9.8
	G6M-02-11X	7/16/2003	530	54	33	2U	1U	2U	5U	120		16M	2.0U	5U	1U		5.0U	14	460	6.31	0.86	166	0.813	11.9	15.4
	G6M-02-11X	9/26/2003	590	31	37	2U	1U	2U	19					5U		1700	5.0U	5.0U	1200	6.6	0.41	146	0.921	7.2	13.9
	G6M-02-11X	1/8/2004	300	15	49	2U	1U	2U	5U	150		12J	2.0U	5U	1U	1900	5.0U	9.3	2300	6.29	0	104	0.729	0.6	10.7
	G6M-02-11X	3/10/2004	160	11	53	2U	1U	2U	1.8	130		9.6M	2U	5U	1U	2200	5U	68	14000	6.39	0.82	103	0.847	7.5	13.2
	G6M-02-11X	6/4/2004	440	23	54	2U	1U	2U	2.4J	110		12M	1.9J	5U	1U	1900	5U	10	2300	6.72	12.13	54.5	0.807	21.3	14.12
	G6M-02-11X	9/22/2004	540	50	140	2U	1U	2U	1.2	100	0.5U	12	1.5J	5U	1U	2400	5U	5U	13000	6.19	0.96	412.7	0.996	1.25	16.05
	G6M-02-11X	12/15/2004	760	47	120	2U	1U	2U	5U	95	1	15	2U	5U	1U	2100	5U	21	9700	6.35	1.36	200.1	0.675	21.2	8.61
	G6M-02-11X	3/28/2005	1100	41	45	40U	40U	40U	3.6J	90	0.2U	13	2UJ*	5U	1UM	2200	5U	65	10000	6.19	1.02	84.3	0.938	48.3	6.55
	G6M-02-11X	7/1/2005	1500	90	280	10U	10U	10U	9.4	98.4	0.05U	14	1U	2.1	1UJ*	1800	28	420	15000	5.78	0.37	221.6	0.806	6.66	15.58
	G6M-02-11X	9/27/2005	240	78	260	2U	1U	16	3.4	148	0.05U	5.9J	1U	5U	1U	2500	20J	8100	21000	5.92	0.4	93.6	0.755	0.69	13.72
	G6M-02-11X	12/12/2005	220	28	50	2U	1U	9.1	5.5	270	1.3	3.5	1U	7.8	1U	3100	82	29000	24000	6.28	0.18	64.8	1.107	8.9	11.09
	G6M-02-11X	3/21/2006	520	94	230	2.3	1U	60	8.2	120	0.2U	8.81	1U	5U	0.1U	1500	25U	34000	17000	6.45	12	326.6	0.765	7.15	13.83
	G6M-02-11X	6/22/2006	130	44	20	20	1U	9.2	6.1	210	0.2U	2.45	1U	5U	0.39	6300	51	78000	22000	6.19	0.27	59.7	1.231	5.04	16.04
	G6M-02-11X	9/22/2006	37	17	8.6	2.8	1U	4	9.8	180	0.2U	4.87	1U	6.9	0.58	9300	89	15000	21000	5.93	1.22	-158.9	1.079	4.55	14.87
Area 5	G6M-02-12X	8/1/2002	330	2U	2U	2U	1U	2U						5U						6.24	0.64	19	0.924	37.6	18.2
	G6M-02-12X	8/28/2002	520	6.5	2U	2U	1U	2U	5U	54				5U						6.15	0.19	156	0.868	2.96	14.2
	G6M-02-12X	10/29/2002	790	10	2U	2U	1U	2U	2.0J	40	0.10U	17	2.0U	5U	1U	1100				6.14	0.27	68	0.927	2.08	13.5
	G6M-02-12X	2/3/2003	580	4	2U	2U	1U	2U	5U	52				5U	1U					6.04		78	0.947	5.06	12.8
	G6M-02-12X	7/14/2003							5U																
	G6M-02-12X	9/22/2004	1000	43	110	2U	1U	2U	1U	84	0.5U	13	2U	5U	1U	450	5U	5U	2900	5.87	0.35	570.2	0.873	4.95	14.83
	G6M-02-12X	9/27/2005	1100	38	250	1.4	1U	5.4	3.5	106	0.05U	13J	1U	5U	1U	690	25U	1100	14000	6.11	1.17	238.5	6.92	24.5	14.01
	G6M-02-12X	9/21/2006	190	88	64	23	1U	67	7.6	170	0.2U	5.72	1U	5U	0.37	3200	38	46000	15000	6.23	0.17	78	0.799	60.6	14.12
Area 5	G6M-03-08X	5/14/2003	750	2U	2U	2U	1U	2U						5U	1U										
	G6M-03-08X	9/22/2004	690	6.3	5.4	2U	1U	2U	1U	16	8.3	13	1.5J	5U	1U	15U	5U	5U	1.8	5.89	1.81	247.6	0.463	3.22	15.28
	G6M-03-08X	12/16/2004	1100	11	9.6	2U	1U	2U	5U	20	5.7	13	2.9	5U	1U	17	69	30	4.7	5.93	0.7	135.7	0.495	8.98	9.73
	G6M-03-08X	3/31/2005	340	20U	9.6J	20U	20U	20U	0.3J	12.0	2.3	17	2U	5U	1U	15U	11	450	14	5.94	1.96	166.3	0.205	0.93	12.88
	G6M-03-08X	7/6/2005	780	8.2	15	2U	1U	2U	5.5	28.6	1.8	14	1U	4U	1U	10U	110	68	410	5.85	0.78	236.1	0.463	5.37	15.32
	G6M-03-08X	9/28/2005	620	4.8	14	1U	1U	1U	5U	28.3	1.6	12	1U	5U	1U	15U	25U	9J	2400M	5.6	3.56	172.3	0.352	8.3	14.79
	G6M-03-08X	12/14/2005	700	8	17	2U	1U	2U	5U	32	1.2	12	1U	5U	1U	15UJ	25U	25U	7000	6.16	0.54	153.8	0.404	3.7	9.71
	G6M-03-08X	3/22/2006	1100	21	34	2.6	1U	2U	6.5	29	0.586	11.7	1U	5U	0.1U	15U	25U	6J	12000	6.28	5.43	394.2	0.299	9.75	11.63
	G6M-03-08X	6/21/2006	610	16	48	2U	1U	2U	5U	41	0.33	10.2	1U	5U	1.8	42	4J	140	16000	5.91	0.29	141.6	0.49	21.4	12.93
	G6M-03-08X	9/21/2006	660	47	110	2U	1U	5.2	3.2J	41	0.228	9.64	1U	5U	0.10U	15U	23J	550	14000	6	2.36	122.5	0.325	17.1	14.49

Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

			Laboratory Parameters																	Field Parameters					
Area of Concern	Well ID	Date	PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
Area 5	G6M-03-09X	5/14/2003	2U	2U	2U	2U	1U	2U						5U	1U										
	G6M-03-09X	9/23/2004	3.7B	2U	2U	2U	1U	2U	1U	23	19	15	2.2	5U	1U	15U	5U	5U	1.9	6.23	8.67	176.2	0.13	4.57	14.33
	G6M-03-09X	12/14/2004	2U	2U	2U	2U	1U	2U	5U	25	11	15	2U	5U	1U	15U	15	26	2	6.08	8.17	417.6	0.106	12.1	10.23
	G6M-03-09X	3/29/2005	1.5J	2U	2U	2U	1U	2U	0.3J	18.0	1.5	13	2U	5U	1UM	15U	13	260	1.4	6.18	6	113.2	0.123	72.4	11.28
	G6M-03-09X	6/30/2005	5.8	2U	2U	2U	1U	2U	15	25.1	1.3	13	1U	2U	1UJ*	10U	77	32	1.2	5.75	2.81	160.2	0.135	53.6	15.19
	G6M-03-09X	9/28/2005	2U	2U	2U	2U	1U	2U	4J	38.2	3.7	13	1U	5U	1U	15U	6J	9J	29M	5.9	10.56	181	0.108	7.6	13.06
	G6M-03-09X	12/13/2005	2U	2U	2U	2U	1U	2U	1.7J	53	0.05U	13	1U	5U	1U	15U	5J	14J	790	6.21	3.06	259.3	0.172	4.9	11.87
	G6M-03-09X	3/22/2006	2U	2U	2U	2U	1U	2U	7.9	36	1.81	12.1	1U	5U	0.1U	20	6J	16J	39	6.4	3	415.5	0.102	10.83	11.9
	G6M-03-09X	6/23/2006	2U	2U	2U	2U	1U	2U	5U	39	2.65	13.2	1U	5U	0.1U	15U	25U	42	390	5.92	4.55	164.9	0.156	16.9	16.01
	G6M-03-09X	9/21/2006	2U	2U	2U	2U	1U	2U	0.8J	36	2.51	9.19	1	5U	0.10U	15U	14J	120	140	6.71	2.24	127.6	0.212	4.56	13.03
Area 5	G6M-03-10X	5/14/2003	15	2U	2U	2U	1U	2U						5U	1.0U										
	G6M-03-10X	9/22/2004	27	2U	2U	2U	1U	2U	1U	51	2.8	12	1.5J	5U	1U	340	50	680	680	6.28	1.28	-77.2	0.539	20.5	15.41
	G6M-03-10X	12/14/2004	19	2U	44	2U	1U	2U	5U	110	3.8	21	2U	5U	1U	880	20	25	1.9	6.52	0.94	62	0.801	1.57	12.1
	G6M-03-10X	3/29/2005	14	0.98J	68	1.2J	1U	2U	5.9	146	0.2U	12	2U	5U	1UM	1200	5U	380	2600	6.44	0.59	-14.5	0.869	6.77	11.09
	G6M-03-10X	6/30/2005	3.6	2U	2U	2U	1U	2U	19	199	0.1	11	1U	2U	1UJ*	1900	26	21	8600	5.18	0.39	273.2	0.702	5.06	16.6
	G6M-03-10X	9/28/2005	6.7	2U	2U	2U	1U	2U	0.6J	140	0.20	16	1U	5U	1U	720	25U	20J	1100M	6.43	4.3	74.1	0.588	7.36	13.41
	G6M-03-10X	12/13/2005	3.4	2U	2U	2U	1U	2U	3.4J	250	0.48	8.4	1U	6.9	1U	3020	9J	27	12000	6.73	0.15	57.2	1.032	1.3	12.12
	G6M-03-10X	3/23/2006	9.9	2U	2U	2U	1U	2U	3.5J	170	0.2U	8.9	1U	5U	0.22	3800	20J	52	7000	6.64	0.67	36.6	0.663	5.39	13.94
	G6M-03-10X	6/22/2006	2.6	2U	2U	2U	1U	2U	5J	200	0.2U	4.44	1U	5U	0.74	7300	4J	42	14000	4.87	0.64	610.8	0.77	0.64	15.96
	G6M-03-10X	9/20/2006	2.2	2U	2U	2U	1U	2U	6	180	0.2U	6.95	1U	5U	0.21	6200	6J	140	14000	6.41	1.26	-140.2	0.856	3.9	14.07
Area 5	G6M-04-05X	9/22/2004	140	2U	2U	2U	1U	2U	1U	14	4.9	14	2U	5U	1U	15U*	5U	9.2	1.3	6.1	9.68	233.9	0.099	0.68	14.76
	G6M-04-05X	12/15/2004	17	2U	2U	2U	1U	2U	5U	14	7.5	13	2U	5U	1U	15U	5U	16	1.4	5.87	1.17	228.7	0.098	1.04	12.74
	G6M-04-05X	3/30/2005	130	10U	10U	10U	5U	10U	0.5J	14	1.2	10	2U	5U	1U	15U	7.4	28	15	6.04	2.8	123.1	0.093	1.92	13.84
	G6M-04-05X	6/30/2005	200	2U	2U	2U	1U	2U	2.4	15.9	0.87	8.9	1U	2U	1UJ*	10U	41	22	96	5.48	0.88	207.1	0.094	8.19	15.41
	G6M-04-05X	9/29/2005	110	2U	2U	2U	1U	2U	5U	3.3	0.98	14	1U	5U	1U	33	6J	12J	220	6.08	0.2	215.3	0.061	2.1	13.53
	G6M-04-05X	12/14/2005	36	2U	2U	2U	1U	2U	5U	21	1.6	11	1U	5U	1U	15U	7J	16J	550	6.1	0.23	179.3	0.091	0.3	12.8
	G6M-04-05X	3/22/2006	330	2U	2U	2U	1U	2U	3.4J	13	1.11	9.33	1U	5U	0.1U	15U	25U	19J	2200	6.21	0.77	343.3	0.062	0.86	12.51
	G6M-04-05X	6/22/2006	38	2U	2U	2U	1U	2U	5U	22	1.82	9.01	1U	5U	0.1U	15U	25U	82	33	4.4	2.55	760.6	0.083	0	13.87
	G6M-04-05X	9/22/2006	30	2U	2U	2U	1U	2U	5U	15	1.51	10.8	1U	5U	0.10U	15U	9J	84	140	5.78	1.48	-127.3	0.123	0.34	13.53
Area 5	G6M-04-06X	9/22/2004	160	2U	2U	2U	1U	2U	1U	110	5.3	8.7	2U	5U*	1U	15U	56	5U	3.4	11.01	9.17	-0.6	0.341	1.34	15.84
	G6M-04-06X	12/16/2004	24	2U	2U	2U	1U	2U	5U	54	7.9	10	2.9	21	1U	15U	17	28	0.47	10.89	9.42	106.9	0.254	2.26	12.77
	G6M-04-06X	3/30/2005	37	2U	2U	2U	1U	2U	5U	37	2.0	12	2U	7.5	1U	15U	8.7	51	0.58	9.47	10.46	10.6	0.235	0.32	15.25
	G6M-04-06X	7/1/2005	140	2U	2U	2U	1U	2U	2.8J	10.3	1.5	25	1U	2U	1UJ*	190	34	56	9.7	9.08	9.77	457.2	0.214	0.95	17.23
	G6M-04-06X	9/29/2005	32	2U	2U	2U	1U	2U	5.4	70.4	1.9	12	1U	11	1U	15U	9J	18J	0.7	9.32	9.43	390.6	0.192	1.99	15.18
	G6M-04-06X	12/15/2005	26	2U	2U	2U	1U	2U	7.6	39	1.9	12	1U	80.9	1U	150	9J	22J	3.3	9.74	10.17	151.2	0.226	0.3	11.92
	G6M-04-06X	3/23/2006	100	2U	2U	2U	1U	2U	5U	23	1.71	9.29	1U	5U	0.1U	15U	6J	36	3.1	8.94	9.46	452.5	0.188	1.72	14.07
	G6M-04-06X	6/23/2006	190	2U	2U	2U	1U	2U	5U	41	1.69	9.43	1U	13	0.1U	15U	12J	41	10	8.66	9.75	165.3	0.254	3.55	17.68
	G6M-04-06X	9/21/2006	45	2U	2U	2U	1U	2U	1.9J	31	1.03	10.9	1U	5U	0.10U	15U	16J	110	6.3	9.46	9.75	66.6	0.347	1.45	15.25

Table 1. Summary of Key Analytical Results and Field Parameter Measurements, AOC 50, Devens, Massachusetts

			Laboratory Parameters																	Field Parameters					
Area of Concern	Well ID	Date	PCE	TCE	c-1,2-DCE	t- 1,2-DCE	1,1-DCE	VC	TOC	Alkalinity	Nitrate	Sulfate	Sulfide	Dissolved Arsenic	Dissolved Iron	Dissolved Manganese	Ethane	Ethene	Methane	pH	DO	ORP	SpC	Turbidity	Temp
			(ug/L)						(mg/L)					(ug/L)	(mg/L)	(ug/L)	(ng/L)		(ug/L)	(SU)	(mg/L)	(mV)	(mS)	(NTUs)	°C
Area 5	G6M-04-07X	9/22/2004	900	2.7	8.4	2U	1U	2U	1U	56	5.4	32	2U	5U	1U	260	61	120	3.1	7.1	3.42	110.1	0.243	9.28	14.61
	G6M-04-07X	12/17/2004	1100	2	9.3	2U	1U	2U	0.6J	43	6.4M	14	2U	28	1U	47	110	2200	2.1	7.51	1.98	-38.9	0.246	74.7	10.34
	G6M-04-07X	3/29/2005	240	10U	10U	10U	5U	10U	0.5J	43.2	1.5	14	2U	12	1UM	27	31	640	1.9	6.88	4.19	22	0.229	4.2	12.76
	G6M-04-07X	7/5/2005	170	2U	2U	2U	1U	2U	5U*	41.1	1.7	14	1U	4	1U	37	70	42	1.8	5.83	5.44	369.9	0.186	23.4	17.93
	G6M-04-07X	9/29/2005	470	3	8.3	2U	1U	2U	5U	1U	1.9	16	1U	5U	1U	43	10J	10J	2.4	6.19	0.86	478.3	0.277	6.62	14.21
	G6M-04-07X	12/14/2005	390	2U	2	2U	1U	2U	6.1	40	1.6	13	1U	3.8B	1U	17.9	6	16	7.9	6.65	4.72	149.3	0.218	34.1	11.92
	G6M-04-07X	3/23/2006	260	2U	2U	2U	1U	2U	5U	36	1.57	13.3	1U	5U	0.1U	15U	5J	29	250	6.28	2.14	619.7	0.267	4.09	13.9
	G6M-04-07X	6/23/2006	150	2U	2U	2U	1U	2U	0.3J	30	1.28	12.5	1U	5U	0.1U	24	5J	22J	22	6.29	5.5	117.8	0.24	8.07	16.14
	G6M-04-07X	9/21/2006	110	2U	2U	2U	1U	2U	3.4J	32	2.54	10	1U	5U	0.10U	19	14J	88	2.4	6.34	4.43	99.8	0.197	2.63	13.66
Area 5	G6M-04-08X	9/24/2004	4.2B	2U	2U	2U	1U	2U												7.29	0.81	-75.5	0.632	52.8	14.46
Area 5	G6M-04-14X	11/16/2004	12	2U	2U	2U	1U	2U																	
	G6M-04-14X	9/27/2005	6.9	2U	2U	2U	1U	2U												7.88	1.6	333	0.263	18	12.69
	G6M-04-14X	9/21/2006	9.4	2U	2U	2U	1U	2U												7.98	3	26.1	0.211	15.7	12.19
Area 5	MW-3	10/17/2001	4300	1500	540	20U	10U	20U												5.7	0.9	-127	1.4	3.1	14
	MW-3	12/19/2001	26	4000	2200	20U	6.5J	20U	92			0.43J								6.28	0.43	-46	0.912	7.28	14.4
	MW-3	1/3/2002							44					180	30		63	210	18	4.77	1.33	-48	2.795	4.4	13.4
	MW-3	1/31/2002							38											6.64	0	-293	0.999		12
	MW-3	2/13/2002	4400	1700	1600	1.6J	3.7	2U	15		0.10U	14	1.0J	190	20	8300	79	290	53	6.65	0.75	-71	0.893	1.3	12
	MW-3	3/13/2002	5200	640	1400	1.4J	2.8	2U	7.3		0.10U	15	2.0U	180	16	8400	93	370	66	6.72	0.25	-75	0.795	1.04	13.7
	MW-3	4/2/2002	3100	1000	1700	2.2	4	2U	3.3J											6.74	4.28	-120	0.634	2.08	13.8
	MW-3	4/17/2002	1200	1300	1600	1.2J	3.4	2U	6.1		3.0	7.9J	1.6J	240	37	17000	25	87	54	6.6	4.39	-102	0.771	0.81	17
	MW-3	5/15/2002	31	23	2600	3.5	6.7	2U	96		0.10U	3.9	1.6J	260	42	19000	52	240	560	6.66	0.31	-124	1.46	1.68	13.7
	MW-3	6/27/2002	200U	200UJ	1800	200UJ	100UJ	200UJ*	270		14	4.4J	2.0U	490J*	140	37000J	21	82	3900	6.7	1.64	-107	3.804	2.9	17
	MW-3	7/31/2002							31											6.76	0.15	-225	1.606		12.2
	MW-3	8/26/2002	990	640	580	2.1	4.4	2U	30	320				270			53	160	14000	6.83	0.15	-138	1.285	6.5	16.3
	MW-3	10/28/2002	1900	820	1700	3.9	4.2	2U	6.3	190	0.10U	10	2.0U	330	39	9700	300	230	6300	6.7	0.4	-129	1.129	5.01	14.5
	MW-3	2/3/2003	3	2U	2900	2U	7.1	2U	180	580		1.0U		330	120		5.0U	260	28000	6.84	0.3	-159	1.322	6.7	10.5
	MW-3	7/16/2003	2.4	2U	2700	2U	7.5	2.5	17	450		4.0UB	2.0U	520	170		5.0U	100	23000	7.02	1.09	-138	1.464	39.2	16.3
	MW-3	9/24/2003	670	1100	1900	2.4	6.9	2U	5.9					460	89	7900	5.0U	12	22000	6.1	9.17	-138	1.222	18.9	16.8
	MW-3	1/9/2004	9.7	64	2000	2U	5.6	2U	130	500J		1.0U	2.0U	530	200J	15000	5.0U	5.0U	45000	6.73	0.4	-195	1.347	14.6	12.7
	MW-3	3/11/2004	680	620	4700	2U	7.6	2U	6.1	200		4.4	2U	420	11	8400	5U	5U	27000	6.58	0.62	-161	0.972	4.3	12.4
	MW-3	6/2/2004	2U	2U	1800	2U	4.5	2U	290	810		0.98JM	2U	670MSA	150	23000	5U	14	31000	6.95	0.1	-149	1.905	38.7	14.61
	MW-3	9/21/2004	210	250	1900	2U	5.2	3.5	17	310	1J*	4.3J*	2UM	660	200J*	7200	86	5U	28000	6.66	0.95	-153.6	0.725	2.27	13.76
	MW-3	12/13/2004	2U	2U	750	2U	1U	610	8	210	1.1	1.4M	2U	510	160	5400	92	3500	17000	6.62	1.6	-103.3	1.009	15.1	11.07
	MW-3	3/28/2005	23J	16J	1000	50U	50U	280	21	405	0.2U	1U	7.5J*	670	150M	7300	5U	5100	25000	6.49	0.34	-134.9	1.26	2.37	12.46
	MW-3	8/10/2005	440	80	120	2U	5.1	760	43	338	0.05U	2U	8	680	180	4400	61J*	13000	22000	11.13	0.71	-118.5	1.401	28.9	18.92
	MW-3	9/27/2005	1100	240	180	1.8	9.1	360	5.6	96.8	0.05U	9.9J	3.4	480	71J	2500	20J	40000	22000	6.36	0.21	-91.2	0.66	2.8	14.17
	MW-3	12/12/2005	37	67	52	20U	10U	480	18	180	0.083	2U	5.6	566	100		55	100000	26000	6.66	0.11	-152.7	1.087	8	12.77
	MW-3	3/20/2006	620	350	120	3.1	3.9	220	13	110	0.2U	6.31	1U	440	85	3600	25U	130000	25000	6.95	0.77	-106.2	0.871	3.71	12.89
	MW-3	6/22/2006	2U	2U	4	7.6	1U	6.1	4J	98	0.2U	1U	1U	520	87	3300	23J	180000	20000	6.4	0.22	-127	1.012	4.18	16.41
	MW-3	9/20/2006	360	420	130	12	5.6	200	9.6	70	0.2U	7.88	1.4	580	70	3300	15J	95000	17000	6.52	0.28	-108.5	0.729	3.56	15.56
Area 5	MW-7	2/14/2002	5900	4.5	2U	2U	1U	2U			5.2	20	0.6J	5U	1U	170J	120	80	8.4	6.12	1.58	104	0.787	90	13.8
	MW-7	3/14/2002	5700	4.2	2U	2U	1U	2U	2.0J		4.1	22J	2.0U	5U	1U	1000U	94	180	5.9J	6.12	2.29	203	0.808	8.85	13.9
	MW-7	4/17/2002	4200	2.9	2U	2U	1U	2U	5U		4.2	18J	1.6J	2.3J	1U	1000U	72	200	6.0	6.11	0.5	145	0.656	19.5	18.8
	MW-7	5/16/2002	5700	4.3	2U	2U	1U	2U	5U		4.3	18J	2.0UJ	5U	1U	1000U	97	200	9.0	6.05	0.21	185	0.759	23.9	15.7
	MW-7	6/27/2002	5300	3.8J*	2UH	2UH	10H	2UH	5U		4.2	19J	2.0U	5U	1U	170UJ				6.13	0.73	163	1.198	100	18.2
	MW-7	8/27/2002	4700	3.5	2U	2U	1U	2U	5U	29				5U						6.13	0.29	136	0.632	1.86	16.1
	MW-7	10/30/2002	5400	2.7	2U	2U	1U	2U	5U	23	4.9	16	2.0U	5U	1U	200J	47	180	20	6.05	0.37	66	0.779	3.63	15.3
	MW-7	12/14/2002							5U																
	MW-7	1/30/2003	4700	3.1	2U	2U	1U	2U	5U	19		16		5U	1U		44	75	23	5.8	2.2	171	0.773	1.08	13.9
	MW-7	9/24/2003	4200	3.3	2U	2U	1U	2U	5U					5U	1U	140	15	27	58	3.4	1.43	522	0.691	0.3	15.7
	MW-7	1/8/2004	4300	2.8	2U	2U	1U	2U	5U	27		14J	2.0U	5U	1U	130	11	26	25	6.02	0	198	0.481	15	11.1
	MW-7	3/12/2004	3100	2.7	2U	2U	1U	2U	1U	24		15M	2U	5U	1U	120	20	280	6.3	6.04	0.47	162	0.556	1	13.9
	MW-7	6/3/2004	2900	2.6	2U	2U	1U	2U	1.5J	24		15M	2U	5U	1U	110	12	34	34	5.96	0.31	205.2	0.58	1.92	14.44
	MW-7	9/21/2004	2900	3.4	3.1	2U	1U	2U						5U	1U	110				5.98	0.21	240.4	0.58	0	15.67
	MW-7	9/27/2005	1600	3.7	5.8	2.5U	2.5U	2.5U						5U	0.2J	110				4.49	0.93	304.1	0.593	3.39	14.5
	MW-7	9/22/2006	4400	9.8	7.7	2U	1U	2U						5U	0.10U	100				5.99	1.19	140.9	0.503	3.01	15.7

Notes:

J	Estimated value	**FDW**	Former Dry Well Area
B	Detected in laboratory blank	**FDSA**	Former Drum Storage Area
U	Less than the detection limit		
H	Sample rerun outside holding time due to "B" detection		
M	Recovery poor for MS/MSD		
*	Value qualified from reported laboratory data based on data validation results.		

Table 2
Interim Groundwater Cleanup Levels

Carcinogenic Chemical of Concern (a)	Cancer Classification	Interim Cleanup Level (ug/L)	Basis	RME Risk (b)
Arsenic	A	10	MCL (c)	2.0E-04
Benzene	A	5	MCL	7.4E-06
1,2-Dichloroethane	B2	5	MCL	1.2E-05
Lead	B2	15	NIPDWR (d)	NC
Methylene chloride	B2	5	MCL	1.0E-06
Tetrachloroethylene	B2	5	MCL	7.0E-06
Trichloroethylene	B2	5	MCL	5.4E-05
Vinyl chloride	A	2	MCL	4.1E-05
Sum of Carcinogenic Risk				3E-04

Noncarcinogenic Chemicals of Concern (e)	Target Endpoint	Interim Cleanup Level (ug/L)	Basis	RME Hazard Quotient (f)
1,1-Dichloroethylene	liver	7	MCL	0.03
1,2-Dichloropropane	--	5	MCL	0.2
cis-1,2-Dichloroethylene	blood	70	MCL	1
Iron	--	3,129	Risk-based concentration (g)	1
Manganese	CNS	1,460	Risk-based concentration (g)	1
Nitrate	blood	10,000	MCL	0.6
Sum of Noncarcinogenic Hazard for Blood Target Endpoint				2

Key

--: no information available
CNS: central nervous system
NC: not calculated due to lack of toxicity data
ug/L: micrograms per liter
RME: reasonable maximum exposure
MCL: Maximum Contaminant Level

a. Includes all detected A, B, or C carcinogens that exceed an ARAR.

b. Risks are calculated for adult residential potable water ingestion and inhalation of volatile organic compounds, assuming exposure to concentrations at the interim cleanup levels. Inhalation risks assumed equal to ingestion risks, where Ingestion Cancer risk = CSF x [(ICL x CF x IR x EF x ED x (1/AT) x (1/BW)], where:

CSF = cancer slope factor (see Table 2, but using updated values where available) $(mg/kg\text{-}day)^{-1}$
ICL = interim cleanup level (as listed in present table) (ug/L)
CF = conversion factor (0.001 mg/ug)
IR = water ingestion rate (2.3 L/day)
EF = exposure frequency (350 day/year)
ED = exposure duration (30 years)
AT = averaging time (10,950 days)
BW = body weight (70 kg)

c. MCL of 10 ug/L for arsenic is not effective until 1/26/06; however, EPA has indicated that this is the maximum interim cleanup level likely to be accepted for arsenic.

d. NIPDWR is a National Interim Primary Drinking Water Regulation, and it is based on treatment technology. EPA has indicated that the NIPDWR is the maximum interim cleanup level likely to be accepted likely to be accepted for lead.

e. Includes all detected chemicals in groundwater that exceed an ARAR and are not A, B, or C carcinogens.

f. Hazards are calculated for child residential potable water ingestionand inhalation of volatile organic compounds, assuming exposure to concentrations at the interim cleanup levels. Inhalation hazards assumed equal to ingestion hazards, where Ingestion Noncancer Hazard = [ICL x CF x IR x EF x ED x (1/AT) x (BW)] / RfD, where,

IR = water ingestion rate (1.5 L/day)
ED = exposure duration (6 years)
BW = body weight (15 kg)
RfD = reference dose (see Table 3, but using updated values where available) (mg/kg-day)
AT = averaging time (2,190 days)
and all other inputs as listed above under footnote b

g. Risk-based concentrations derived in Table 8

Table 3
Interim Porewater Cleanup Levels

Ecological Chemical of Concern (a)	**Interim Cleanup Level (ug/L)**	**Basis**	**Maximum Hazard Quotient (b)**
cis-1,2-Dichloroethylene	31.2	Tier II SCV	7
Lead	2.5	AWQC at hardness of 100 mg/L	2
Manganese	1,930	FCV at hardness of 100 mg/L	3
Tetrachloroethylene	125	Tier II SCV	4

Key
ug/L: micrograms per liter
AWQC: chronic freshwater Ambient Water Quality Criteria (USEPA 2002)
FCV: Final Chronic Value (MDEQ 2002)
Tier II SCV: Tier II Secondary Chronic Value (Suter 1996)

a. Includes all detected chemicals in groundwater for which hazard quotients calculated for benthic organisms from maximum concentrations exceed 1.

b. Based on direct contact of benthic organisms with maximum detected concentrations in groundwater (as a surrogate for porewater).

Table 4. Enhanced Reductive Dehalogenation (ERD) Design and Performance Criteria for OPS Certification

AOC 50, Devens, MA

<table>
<tr><td colspan="2"><i>REMEDIAL OBJECTIVE: The objective of the ERD implementation is to expedite the degradation of CVOCs in the groundwater by stimulating microbial activity.</i></td></tr>
<tr><td colspan="2">Criteria for Proper(1) Operation:</td></tr>
<tr><td><i>Design Criteria:</i></td><td><i>Supporting evidence:</i></td></tr>
<tr><td rowspan="4"><i>Constructed as Designed</i></td><td>Installed 40 injection wells across the site for addition of carbohydrate substrate to the subsurface to stimulate microbial growth in the impacted groundwater zones.</td></tr>
<tr><td>Constructed substrate solution injection trailer with manifold system for the addition of the substrate to the subsurface through the injection wells.</td></tr>
<tr><td>Constructed storage area for injection system trailer</td></tr>
<tr><td>Documented construction of ERD system with as-builts included in O&M Manual (July, 2005)</td></tr>
<tr><td rowspan="7"><i>Operating as Designed</i></td><td>Conducted above-ground handling and delivery of 10,000 gallons of substrate solution per month to 40 injection wells spread across the site.</td></tr>
<tr><td>Injected substrate solutions at design volumes at all injection wells.</td></tr>
<tr><td>Operated and maintained active ERD zones downgradient of injection well transects with sufficient distribution of TOC within the subsurface to create biostimulation effects within the ERD zone.</td></tr>
<tr><td>Completed regular monthly applications of substrate to the subsurface since start of site-wide operations in September, 2004, documented in regular quarterly and yearly O&M repots</td></tr>
<tr><td>O&M manual completed and approved, July, 2005.</td></tr>
<tr><td>Quarterly O&M reports submitted 2004/2005 with annual O&M report for 2004/2005 to be submitted in 2005</td></tr>
<tr><td>ERD system operation designed to limit transient inorganic water quality issues to within the ERD zone.</td></tr>
<tr><td rowspan="4"><i>Monitoring Network Installed</i></td><td>Installed additional monitoring wells for the ERD process.</td></tr>
<tr><td>Developed and implemented a site-wide Long Term Monitoring Plan (as part of the Draft RAWP) with locations, frequency, and analyses (February, 2004)</td></tr>
<tr><td>Developed an approved O&M Manual with operational guidelines, frequency of O&M, evaluating criteria, and guidance for process optimization.</td></tr>
<tr><td>Monitoring plan consistent with the approach demonstrated with the long term pilot test of the ERD process at the site.</td></tr>
<tr><td colspan="2">Criteria for Successful(2) Operation:</td></tr>
<tr><td><i>Performance Criteria:</i></td><td><i>Supporting evidence:</i></td></tr>
<tr><td rowspan="4"><i>Biostimulation and Anaerobic Conditions Developed within the ERD Areas</i></td><td>In-situ distribution of TOC within the targeted ERD areas</td></tr>
<tr><td>In-situ biostimulation through degradation of TOC</td></tr>
<tr><td>In-situ production of methane</td></tr>
<tr><td>Patterns of microbial growth, TOC degradation, metals reduction, and methane production across the site at the ERD areas are the same as demonstrated at the pilot test area</td></tr>
<tr><td rowspan="4"><i>Contaminant Degradation by the ERD Process</i></td><td>Geochemical conditions are consistent with the ERD process criteria</td></tr>
<tr><td>PCE levels decreasing within the ERD areas established to date and are consistent with the pilot test area</td></tr>
<tr><td>Total CVOC concentrations as mmols are decreasing within ERD areas</td></tr>
<tr><td>Intermediate degradation by-products are decreasing with PCE reductions</td></tr>
<tr><td rowspan="4"><i>Contaminant Degradation Rates Consistent with the Model Predictions</i></td><td>ERD system operation has limited transient inorganic water quality issues to within the ERD zone; dissolved arsenic water quality standard (10 ppb) has not been exceeded outside of the established ERD areas.</td></tr>
<tr><td>PCE/TCE degradation rates are consistent with the model predictions and are consistent with the pilot test area</td></tr>
<tr><td>Degradation rates of VOC by-products (DCE, VC) are consistent with the model predictions and the pilot test area</td></tr>
<tr><td>Overall degradation rates of total CVOC are sufficient to meet or exceed the site project timeline for completing remediation</td></tr>
</table>

1) "Proper" operation is defined as "operating as designed", as described in: " Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully Under CERCLA Section 120(h)(3)", by the Office of Solid Waste and Emergency Response, Interim document, August, 1996.

2) "Successful" operation of a remedial system is defined as "its operation will achieve the cleanup levels or performance goals delineated in the decision document", additionally, "that remedy must be protective of human health and the environment" as described in: " Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully Under CERCLA Section 120(h)(3)", by the Office of Solid Waste and Emergency Response, Interim document, August, 1996.

Table 5. In-Well Stripping (IWS) Design and Performance Criteria for OPS Certification

AOC 50, Devens, MA

REMEDIAL OBJECTIVE: The IWS application is intended to reduce the potential for migration of elevated concentrations of VOCs downgradient toward the Nashua River, thereby mitigating potential future ecological risk. In addition, the IWS application will provide an aerobic and oxidizing barrier capable of curtailing the potential downgradient migration of dissolved inorganic compounds and PCE degradation products associated with the ERD application.

Criteria for Proper(1) Operation:

Design Criteria:	*Supporting evidence:*
Constructed as Designed	Installed two IWS wells with mechanical and control components as designed
	Completed start-up and shake-down of IWS system as summarized in start-up report (October, 2004)
	Completed and submitted approved O&M manual with as-builts for IWS system as designed (July, 2005)
Operating as Designed	Established effective plume capture zone and radius of influence as presented in IWS start-up report (October, 2004)
	Both IWS wells pumping, recirculating, and treating groundwater
	Delivering sparge air to treat groundwater
	Treating the extracted groundwater by significantly lowering the PCE concentration
	Saturating the groundwater with dissolved oxygen within the well at the design pumping rate
	O&M manual completed and approved (July, 2005)
	On-going operation and monitoring with uptime for the two wells of 92%
	Quarterly O&M Reports submitted for 2004/2005 and annual report to be submitted for 2005
Monitoring Network Installed	Installation of downgradient Wells G6M-04-06X and G6M-04-07X and upgradient Wells G6M-04-05X and G6M-03-08X for IWS system monitoring
	Established effective capture zone and radius of influence during start-up of IWS system
	Monitoring VOC treatment/removal effectiveness of each IWS well on a monthly basis
	Monitoring in-situ effectiveness of IWS system at downgradient Wells G6M-04-06X and G6M-04-07X and upgradient Wells G6M-04-05X and G6M-03-08X

Criteria for Successful(2) Operation:

Performance Criteria:	*Supporting evidence:*
Remove PCE Mass in IWS Area and Improve Downgradient Groundwater Quality	Pumping at ~20-30 gpm (total), this is in excess of the PCE-impacted GW flow into the area
	Removing ~90% of PCE mass in groundwater flowing into the IWS capture area
	PCE concentrations at Well G6M-04-07X were reduced from 1,100 ppb on 12/17/04 to 170 ppb on 07/05/05, an 85% reduction in groundwater PCE concentrations, documented in regular quarterly and annual O&M reports
Develop an In-situ Aerobic Barrier Down Gradient of ERD Application Areas	Pumping at ~20-30 gpm (total), this is excess of the GW flow into the area
	Delivering sparge air at ~80-100 cfm per well and raising DO levels to saturation
	Transferring ~1.4 lbs/day of oxygen to groundwater, or a total of ~700 pounds to date
	Reduced iron has not been detected or impacted operation of the IWS wells
	Downgradient monitoring wells G6M-04-06X and 07X show elevated DO and ORP levels

1) "Proper" operation is defined as "operating as designed", as described in: " Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully Under CERCLA Section 120(h)(3)", by the Office of Solid Waste and Emergency Response, Interim document, August, 1996.

2) "Successful" operation of a remedial system is defined as "its operation will achieve the cleanup levels or performance goals delineated in the decision document", additionally, "that remedy must be protective of human health and the environment" as described in: " Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully Under CERCLA Section 120(h)(3)", by the Office of Solid Waste and Emergency Response, Interim document, August, 1996.

Table 6. Summary of Substrate Reagent Injections, Full Scale ERD System, AOC 50, Devens, Massachusetts

Well ID	Injection Event (dd-mm-yy)	Solution Injected (gal)	Solution Strength (%)	Carbs Added (lbs)	Hydrated Ferrous Sulfate (lbs)	Amonium PolyPhosphate (gal)	Average Injection Time (hh:mm)	Average Pressure at Well Head (psi)	Average Flow Rate to Well (gpm)
Source Area:	4-Oct-04	2,534	10%	1,292			0:25	3.75	5.49
	4-Nov-04	2,400	13%	1,591			0:13	7.33	9.29
	30-Nov-04	1,600	10%	816			0:10	4.30	8.05
	4-Jan-05	1,600	10%	816			0:10	4.60	7.83
	27-Jan-05	5,000	10%	2,550			0:24	14.38	10.63
	17-Mar-05	2,400	10%	1,224			0:17	12.47	7.63
	15-Apr-05	1,440	10%	734			0:07	6.80	10.93
	20-May-05	1,600	10%	816			0:34	9.65	4.44
	27-Jun-05	2,060	10%	1,051	206		0:16	3.83	6.71
	21-Jul-05	2,060	10%	1,051	206		0:19	2.19	2.19
	25-Aug-05	2,060	10%	1,051	206		0:19	8.53	7.13
	22-Sep-05	2,060	10%	1,051	206		0:11	3.94	9.44
	20-Oct-05	2,060	10%	1,051	206		0:15	3.44	7.27
	16-Nov-05	2,060	10%	1,051	206		0:12	8.75	8.44
	28-Dec-05	2,000	10%	1,020	200		0:11	4.44	9.06
	25-Jan-06	2,400	10%	1,224	240		0:17	8.25	5.60
	23-Feb-06	2,000	10%	1,020	200		0:15	4.50	6.23
	22-Mar-06	2,000	10%	1,020	0	8.00	0:22	10.69	7.47
	20-Apr-06	2,000	10%	1,020	0	8.00	0:20	4.69	5.39
	25-May-06	2,000	10%	1,020	200	0.00	0:21	2.60	5.95
	22-Jun-06	2,000	10%	1,020	200	0.00	0:22	3.67	5.43
Source Area Subtotals:		**45,334**		**23,488**	**2,276**	**16.00**	**0:17**	**6.32**	**7.17**
Area 2:	04-Oct-04	1,770	10%	903			0:28	3.51	13.33
	04-Nov-04	520	13%	345			0:10	0.00	12.16
	30-Nov-04	680	10%	347			0:15	2.50	11.58
	04-Jan-05	680	10%	347			0:07	0.13	24.61
	14-Feb-05	1,240	10%	632			0:25	0.00	0.00
	17-Mar-05	170	10%	87			0:07	0.00	6.07
	15-Apr-05	720	10%	367			0:15	1.25	11.44
	20-May-05	820	10%	418			0:16	1.75	12.81
	27-Jun-05	1,800	10%	918	180		1:35	4.76	5.00
	21-Jul-05	1,800	10%	918	180		0:30	0.00	11.41
	28-Aug-05	1,800	10%	918	180		0:42	0.00	13.63
	22-Sep-05	1,800	10%	918	180		0:43	0.00	13.68
	20-Oct-05	1,800	10%	918	180		0:47	0.50	10.41
	16-Nov-05	1,800	10%	918	180		0:48	0.50	9.88
	28-Dec-05	1,600	10%	816	160		0:34	0.00	11.29
	25-Jan-06	2,000	10%	1,020	200		0:40	0.00	11.65
	23-Feb-06	1,600	10%	816	160		0:43	3.50	9.13
	22-Mar-06	1,600	10%	816	0	6.40	1:10	0.00	13.85

Table 6. Summary of Substrate Reagent Injections, Full Scale ERD System, AOC 50, Devens, Massachusetts

Well ID	Injection Event (dd-mm-yy)	Solution Injected (gal)	Solution Strength (%)	Carbs Added (lbs)	Hydrated Ferrous Sulfate (lbs)	Amonium PolyPhosphate (gal)	Average Injection Time (hh:mm)	Average Pressure at Well Head (psi)	Average Flow Rate to Well (gpm)
	20-Apr-06	1,600	10%	816	0	6.40	0:50	0.00	6.97
	25-May-06	1,600	10%	816	160	0.00	0:36	0.00	10.13
	22-Jun-06	1,600	10%	816	160	0.00	0:33	0.00	12.14
Area 2 Subtotals:		**29,000**		**14,870**	**1,920**	**12.80**	**0:35**	**0.88**	**11.01**
Area 3:	04-Oct-04	1,800	10%	918			0:29	3.01	8.61
	04-Nov-04	650	13%	431			0:10	0.00	12.16
	30-Nov-04	850	10%	434			0:11	0.00	16.59
	04-Jan-05	850	10%	434			0:17	0.00	9.71
	14-Feb-05	1,250	10%	638			0:54	0.00	4.63
	17-Mar-05	650	10%	332			0:11	5.80	12.24
	15-Apr-05	900	10%	459			0:14	4.00	12.93
	20-May-05	1,025	10%	523			0:32	1.10	6.41
	27-Jun-05	2,425	10%	1,237	243		0:54	0.30	9.06
	21-Jul-05	2,425	10%	1,237	243		0:43	1.50	11.20
	25-Aug-05	2,425	10%	1,237	243		0:56	1.30	7.32
	22-Sep-05	2,425	10%	1,237	243		0:43	0.48	11.67
	20-Oct-05	2,425	10%	1,237	243		0:54	1.20	9.36
	16-Nov-05	2,425	10%	1,237	243		0:43	0.00	11.50
	28-Dec-05	2,000	10%	1,020	200		0:56	0.00	11.50
	25-Jan-06	2,500	10%	1,275	250		0:47	2.00	9.91
	23-Feb-06	2,250	10%	1,148	225		0:48	1.20	6.56
	22-Mar-06	2,250	10%	1,148	0	9.00	0:35	0.60	13.39
	20-Apr-06	2,250	10%	1,148	0	9.00	0:43	0.00	10.05
	25-May-06	2,250	10%	1,148	225	0.00	0:39	0.00	12.13
	22-Jun-06	2,250	10%	1,148	225	0.00	0:45	0.00	10.51
Area 3 Subtotals:		**38,275**		**19,620**	**2,580**	**18.00**	**0:37**	**1.07**	**10.35**
Area 4:	04-Oct-04	1,800	10%	918			0:33	1.55	10.52
	04-Nov-04	650	13%	431			0:10	-0.40	12.38
	30-Nov-04	850	10%	434			0:17	0.00	10.13
	04-Jan-05	850	10%	434			0:20	0.00	8.50
	14-Feb-05	1,250	10%	638			0:30	0.00	8.33
	17-Mar-05	650	10%	332			0:13	4.20	9.82
	15-Apr-05	850	10%	434			0:17	2.50	10.03
	20-May-05	1,025	10%	523			0:14	1.50	14.64
	27-Jun-05	2,500	10%	1,275	250		1:08	0.80	7.36
	21-Jul-05	2,500	10%	1,275	250		0:41	0.00	12.77
	25-Aug-05	2,500	10%	1,275	250		0:53	1.90	8.78
	22-Sep-05	2,500	10%	1,275	250		1:16	0.28	6.00
	20-Oct-05	2,500	10%	1,275	250		0:53	0.80	9.58
	16-Nov-05	2,500	10%	1,275	250		0:49	10.00	9.70

Table 6. Summary of Substrate Reagent Injections, Full Scale ERD System, AOC 50, Devens, Massachusetts

Well ID	Injection Event (dd-mm-yy)	Solution Injected (gal)	Solution Strength (%)	Carbs Added (lbs)	Hydrated Ferrous Sulfate (lbs)	Amonium PolyPhosphate (gal)	Average Injection Time (hh:mm)	Average Pressure at Well Head (psi)	Average Flow Rate to Well (gpm)
	28-Dec-05	2,400	10%	1,224	240		0:40	3.80	7.46
	25-Jan-06	3,000	10%	1,530	300		0:51	0.00	10.23
	23-Feb-06	2,700	10%	1,377	270		1:16	0.80	7.65
	22-Mar-06	2,700	10%	1,377	0	10.80	1:19	1.40	9.11
	20-Apr-06	2,700	10%	1,377	0	10.80	0:57	0.00	8.32
	25-May-06	2,700	10%	1,377	270	0.00	0:56	0.00	7.43
	22-Jun-06	2,700	10%	1,377	270	0.00	0:54	0.00	3.59
Area 4 Subtotals:		**41,825**		**21,430**	**2,850**	**21.60**	**0:43**	**1.39**	**9.16**
Area 5:	Pilot test:	***36,182***	10%	***18,453***					
	04-Oct-04	2,280	10%	1,163			0:33	1.14	10.72
	04-Nov-04	780	13%	517			0:14	0.00	9.58
	30-Nov-04	1,020	10%	520			0:28	0.83	6.07
	04-Jan-05	1,020	10%	520			0:24	0.00	7.07
	14-Feb-05	1,500	10%	765			0:30	0.00	7.07
	17-Mar-05	780	10%	398			0:11	4.40	12.30
	15-Apr-05	1,020	10%	520			0:16	2.20	10.12
	20-May-05	1,230	5%	314			0:15	0.33	13.67
	27-Jun-05	1,200	10%	612	120		0:29	0.60	6.80
	21-Jul-05	2,400	5%	612	240		0:20	0.50	8.66
	25-Aug-05	2,400	5%	612	240		0:26	1.20	7.63
	22-Sep-05	2,400	5%	612	240		0:29	1.80	11.09
	20-Oct-05	2,400	5%	612	240		1:06	1.10	8.65
	16-Nov-05	2,400	5%	612	240		1:12	0.00	10.91
	28-Dec-05	1,980	10%	1,010	198		1:01	4.00	8.66
	25-Jan-06	0	0%	0	0		0:00	0.00	0.00
	23-Feb-06	2,700	5%	689	270		0:49	1.70	8.90
	22-Mar-06	2,700	5%	689	0	5.40	0:40	1.30	8.46
	20-Apr-06	2,700	5%	689	0	5.40	0:49	0.00	7.63
	25-May-06	2,700	5%	689	270	0.00	0:55	0.00	7.80
	22-Jun-06	2,700	5%	689	270	0.00	0:48	0.00	8.04
Area 5 Subtotals:		**74,492**		**31,294**	**2,328**	**10.80**	**0:34**	**1.01**	**8.56**

TOTALS: **228,926** gallons

110,701 pounds of carbohydrates
11,954 pounds of hydrated ferrous sulfate
79 pounds of amonium polyphosphate

Table 7. Summary of IWS System Operation and Mass Transfer Rates, AOC 50, Devens, Massachusetts

Date & Time	Well	Pumping Rate	Well Run Time	Groundwater Treated	Influent PCE	Effluent PCE	PCE Removal	PCE Mass Transfer			DO Mass Transfer	
		(gpm)	(hours)	(1000 gal)	(ug/l)$^{(4)}$	(ug/l)$^{(4)}$	(ug/l)$^{(4)}$	(lbs/day)	(lbs/day/ 10 gpm)	(total lbs)	(lbs/day)$^{(5)}$	(total lbs)
IWS-1 Operation:												
5/28/2004	IWS-1	10	5	3	580	70	510	0.061		0.013	0.720	0.15
6/30/2004	IWS-1	14	336	281	330	53	277	0.047		0.655	1.008	14.06
7/28/2004	IWS-1	15	592	511	290	28	262	0.047		1.158	1.080	25.58
8/27/2004	IWS-1	14	1117	952	220	26	194	0.033		1.871	1.008	47.64
10/6/2004	IWS-1	12.2	2077	1,655	170	17	153	0.022		2.768	0.879	82.79
11/3/2004	IWS-1	11.4	2752	2,117	170	13	157	0.021		3.372	0.821	105.89
12/16/2004	IWS-1	16.7	3752	3,119	57	18	39	0.008		3.698	1.203	156.01
1/13/2005	IWS-1	14.9	4418	3,712	120	13	107	0.019		4.227	1.070	185.70
2/7/2005	IWS-1	15.0	5018	4,251	130	15	115	0.021		4.744	1.079	212.66
4/28/2005	IWS-1	14.3	6269	5,328	180	23	157	0.027		6.154	1.033	266.53
5/19/2005	IWS-1	15.0	6774	5,782	110	18	92	0.017		6.502	1.079	289.23
6/28/2005	IWS-1	12.2	7693	6,456	110	19	91	0.013		7.013	0.881	322.96
7/22/2005	IWS-1	11.4	8266	6,850	150	28	122	0.017		7.414	0.824	342.66
8/11/2005	IWS-1	9.4	8517	6,991	180	27	153	0.017		7.594	0.675	349.72
9/12/2005	IWS-1	8.6	8669	7,070	340	45	295	0.031		7.787	0.623	353.66
10/5/2005	IWS-1	14.3	9222	7,546	200	33	167	0.029		8.450	1.033	377.46
11/2/2005	IWS-1	12.2	9912	8,052	120	19	101	0.015		8.876	0.881	402.79
12/9/2005	IWS-1	14.3	10780	8,799	120	15	105	0.018		9.530	1.033	440.15
1/6/2006	IWS-1	13.7	11451	9,350	120	16	104	0.017		10.008	0.985	467.70
2/10/2006	IWS-1	13.0	12287	10,001	130	14	116	0.018		10.637	0.934	500.25
3/20/2006	IWS-1	13.0	13199	10,710	210	20	190	0.030		11.761	0.934	535.75
4/12/2006	IWS-1	14.3	13695	11,137	290	31	259	0.045		12.682	1.033	557.09
5/12/2006	IWS-1	13.0	14270	11,585	250	22	228	0.036		13.534	0.934	579.50
6/30/2006	IWS-1	11.4	14278	11,590	250	*22*	*228*	0.031		13.544	0.824	579.77
IWS-2 Operation:												
6/30/2004	IWS-2	14	4	3	330	36.5	293.5	0.049		0.008	1.008	0.17
7/28/2004	IWS-2	15	256	230	230	25	205	0.037		0.396	1.080	11.51
8/27/2004	IWS-2	14	781	671	220	25	195	0.033		1.113	1.008	33.57
10/6/2004	IWS-2	13	1741	1,420	110	25	85	0.013		1.643	0.936	71.03
11/3/2004	IWS-2	11	2416	1,865	170	14	156	0.021		2.223	0.792	93.31
12/16/2004	IWS-2	11	3219	2,395	41	5.1	35.9	0.005		2.381	0.792	119.82
1/13/2005	IWS-2	10.8	3885	2,826	170	11	159	0.021		2.952	0.776	141.36
2/7/2005	IWS-2	11.4	4485	3,238	170	10	160	0.022		3.501	0.824	161.96
4/28/2005	IWS-2	12.4	6155	4,479	180	15	165	0.025		5.208	0.892	224.03
5/19/2005	IWS-2	12.2	6660	4,849	150	9	141	0.021		5.644	0.881	242.57
6/28/2005	IWS-2	9.7	7626	5,409	160	5.5	154.5	0.018		6.365	0.697	270.58
7/22/2005	IWS-2	8.6	8199	5,707	140	0	140	0.015		6.713	0.623	285.48
8/11/2005	IWS-2	10.2	8678	6,001	220	3.8	216.2	0.027		7.242	0.737	300.16
9/12/2005	IWS-2	9.7	8777	6,058	270	8.4	261.6	0.030		7.368	0.697	303.05
10/5/2005	IWS-2	11.8	9055	6,255	170	14	156	0.022		7.623	0.847	312.86
11/2/2005	IWS-2	11.4	9267	6,400	140	11	129	0.018		7.780	0.824	320.14
12/9/2005	IWS-2	12.2	9827	6,811	220	11	209	0.031		8.496	0.881	340.71
1/6/2006	IWS-2	10.6	10498	7,238	130	14	116	0.015		8.908	0.763	362.04
2/10/2006	IWS-2	7.5	11335	7,614	220	14	206	0.019		9.554	0.540	380.86
3/20/2006	IWS-2	6.1	11930	7,832	260	11	249	0.018		10.008	0.441	391.78
4/12/2006	IWS-2	12.2	12112	7,965	130	34	96	0.014		10.114	0.881	398.43
5/12/2006	IWS-2	13.0	12520	8,283	210	35	175	0.027		10.578	0.934	414.33
6/30/2006	IWS-2	11.4	12986	8,603	470	69	401	0.055		11.647	0.824	430.34

Table 7. Summary of IWS System Operation and Mass Transfer Rates, AOC 50, Devens, Massachusetts

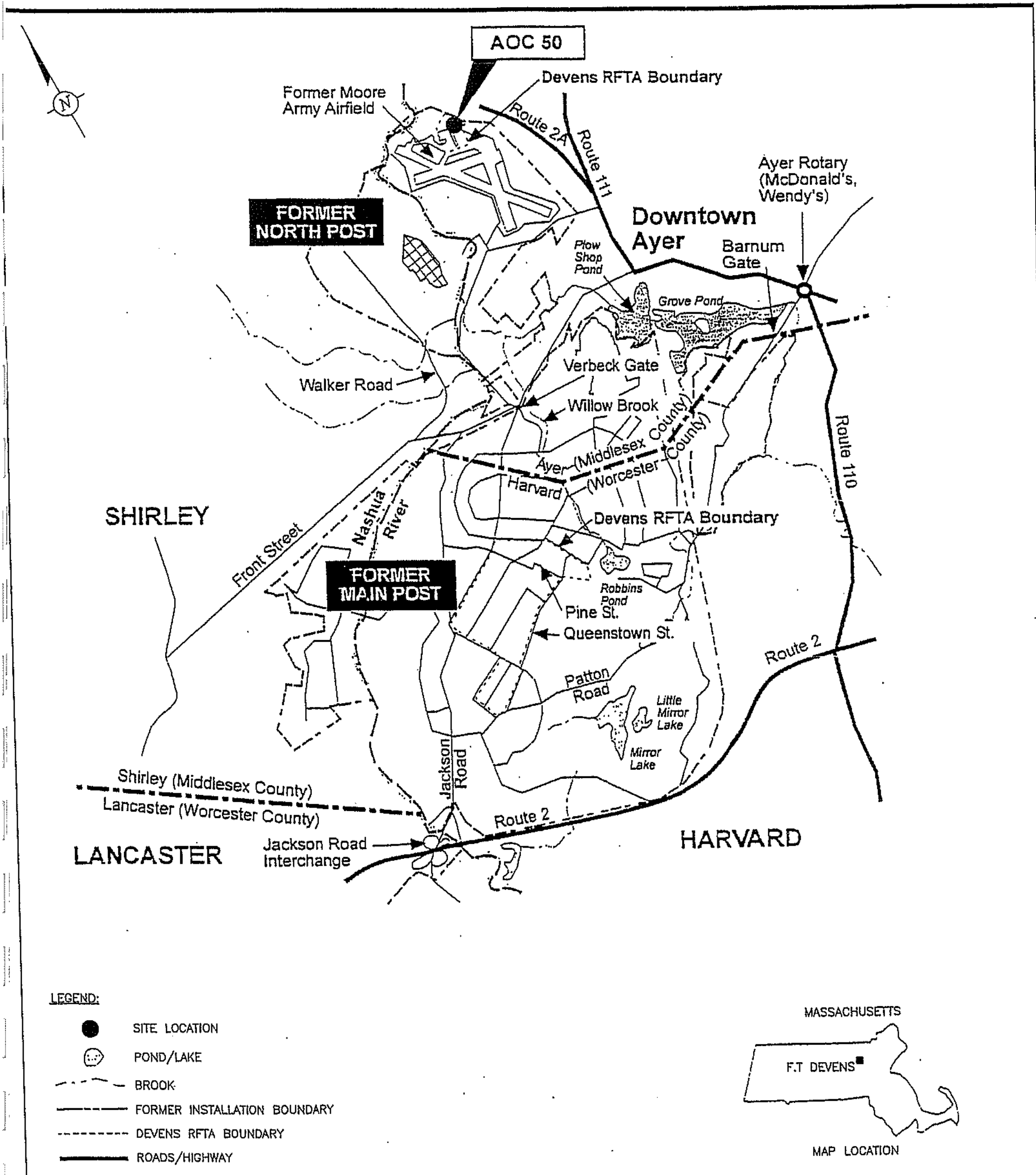
Date & Time	Well	Pumping Rate	Well Run Time	Groundwater Treated	Influent PCE	Effluent PCE	PCE Removal	PCE Mass Transfer			DO Mass Transfer	
		(gpm)	(hours)	(1000 gal)	(ug/l)$^{(4)}$	(ug/l)$^{(4)}$	(ug/l)$^{(4)}$	(lbs/day)	(lbs/day/ 10 gpm)	(total lbs)	(lbs/day)$^{(5)}$	(total lbs)
Combined IWS Operation:			(days)		Avg	Avg	Avg					
5/28/2004	IWS-I	10	0.21	3	580	70	510	0.061	0.061	0.013	0.720	0.15
6/30/2004	BOTH	28	14	284	330	45	285	0.096	0.034	0.663	2.017	14.23
7/28/2004	BOTH	30	25	742	260	27	234	0.084	0.028	1.554	2.161	37.10
8/27/2004	BOTH	28	47	1,624	220	26	195	0.065	0.023	2.984	2.017	81.22
10/6/2004	BOTH	25.2	87	3,075	140	21	119	0.036	0.014	4.411	1.815	153.82
11/3/2004	BOTH	22.4	115	3,982	170	14	157	0.042	0.019	5.595	1.614	199.20
12/16/2004	BOTH	27.7	156	5,514	49	12	37	0.013	0.005	6.079	1.995	275.84
1/13/2005	BOTH	25.6	184	6,538	145	12	133	0.040	0.015	7.179	1.846	327.06
2/7/2005	BOTH	26.4	209	7,489	150	13	138	0.043	0.016	8.246	1.903	374.62
4/28/2005	BOTH	26.7	261	9,807	180	19	161	0.052	0.019	11.362	1.925	490.56
5/19/2005	BOTH	27.2	282	10,631	130	14	117	0.037	0.014	12.146	1.960	531.80
6/28/2005	BOTH	21.9	321	11,865	135	12	123	0.031	0.014	13.378	1.578	593.54
7/22/2005	BOTH	20.1	344	12,557	145	14	131	0.031	0.016	14.127	1.447	628.14
8/11/2005	BOTH	19.6	355	12,992	200	15	185	0.044	0.022	14.836	1.412	649.88
9/12/2005	BOTH	18.3	361	13,128	305	27	278	0.061	0.033	15.155	1.320	656.71
10/5/2005	BOTH	26.1	384	13,800	185	24	162	0.051	0.019	16.073	1.880	690.33
11/2/2005	BOTH	23.7	413	14,452	130	15	115	0.033	0.014	16.656	1.705	722.93
12/9/2005	BOTH	26.6	449	15,610	170	13	157	0.049	0.018	18.026	1.914	780.86
1/6/2006	BOTH	24.3	477	16,587	125	15	110	0.032	0.013	18.916	1.748	829.74
2/10/2006	BOTH	20.5	512	17,614	175	14	161	0.037	0.018	20.191	1.474	881.10
3/20/2006	BOTH	19.1	550	18,542	235	16	220	0.048	0.025	21.769	1.375	927.53
4/12/2006	BOTH	26.6	571	19,102	210	33	178	0.059	0.022	22.797	1.914	955.52
5/12/2006	BOTH	25.9	595	19,868	230	29	202	0.063	0.024	24.112	1.869	993.83
6/30/2006	BOTH	22.9	614	20,193	*360*	*46*	*315*	0.086	0.038	25.192	1.648	1010.11
									PCE:	**25.2**	**DO:**	**1010**

Abbreviations:

gpm - gallons per minute
gal - gallons
µg/L - micrograms per liter
mg/L - milligrams per liter
lbs - pounds

Notes:

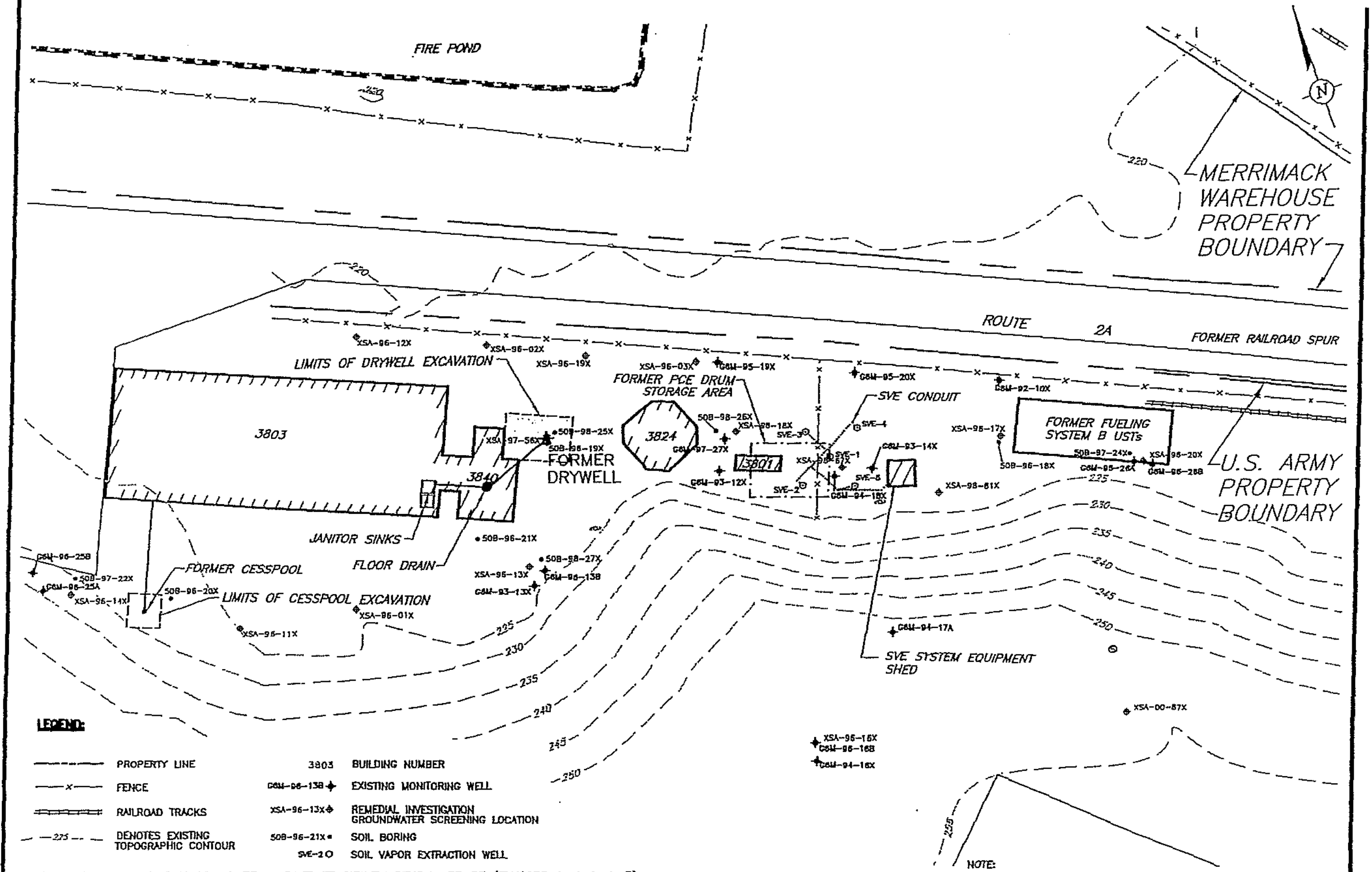
1. VOCs in water were determined by analysis with EPA method 8260B with GC/MS by EPA 5030B.
2. Dissolved oxygen mass transfer is based on an average influent DO of 4 mg/l and an effluent DO of 10 mg/l
3, Values in *italics* are assumed based upon previous Site data.



SOURCE : HARDING LAWSON ASSOCIATES, DRAFT FEASIBILITY STUDY REPORT (FIGURES 1-1)

copyright © 20 02	0 4000 SCALE IN FEET G:\DRAFTING\DWG\FORT DEVENS\D & M\ SITE LOCATION.DWG 11/16/2006 - 10:12:45 AM	ARCADIS	DRAWN M. WASILEWSKI	DATE 2/22/02
			SITE LOCATION AOC 50 DEVENS, MASSACHUSETTS	

PROJECT MANAGER C. CASTELLUCCIO	DEPARTMENT MANAGER A. HANNUM
LEAD DESIGN PROF. M. HANSEN	CHECKED J. HORST
PROJECT NUMBER MA000664.0001	FIGURE NUMBER 1



SOURCE : HARDING LAWSON ASSOCIATES, DRAFT FEASIBILITY STUDY REPORT (FIGURES 1-4 & 1-5)

NOTE:
ELEVATIONS REFER TO NGVD OF 1929.

G:\DRAFTING\DWG\[illegible]\XED\2 AOC-50 SOURCE AREA.dwg Jan. 21, 2004

0 60
SCALE IN FEET

ARCADIS

175 Cobot Street, Suite 400
Lowell, Massachusetts 01854
Tel: 978/937-9999 Fax: 978/937-7555

DRAWN
M. WASILEWSKI

DATE
2/08/02

PROJECT MANAGER
C. CASTELLUCCIO

DEPARTMENT MANAGER
A. HANNUM

SOURCE AREA

AOC 50

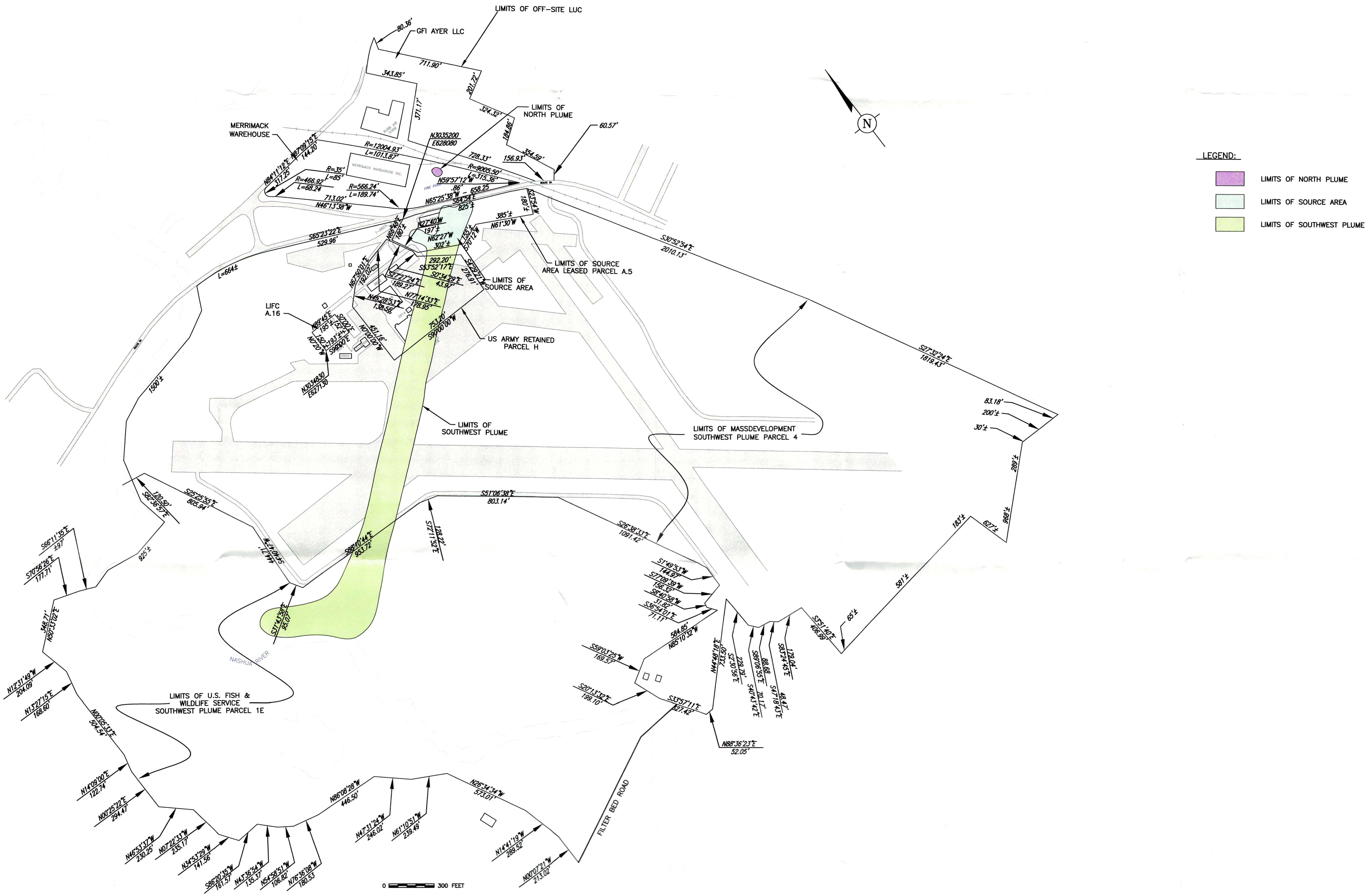
DEVENS, MASSACHUSETTS

LEAD DESIGN PROF.
M. HANSEN

CHECKED
J. HORST

PROJECT NUMBER
MA000664.0001

DRAWING NUMBER
2



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User Name : ccastelluccio Path\Name : G:\ENV\FORT DEVENS\MA000664\ENV\CAD\FD-005 OPS.dwg Layout Tab: Layout1

Area Manager
D. KNOX

Project Director
C. CASTELLUCCIO

Task Manager
C. CASTELLUCCIO

Technical Review
C. CASTELLUCCIO

ARCADIS
SUITE 400
175 CABOT STREET
LOWELL, MASSACHUSETTS 01854
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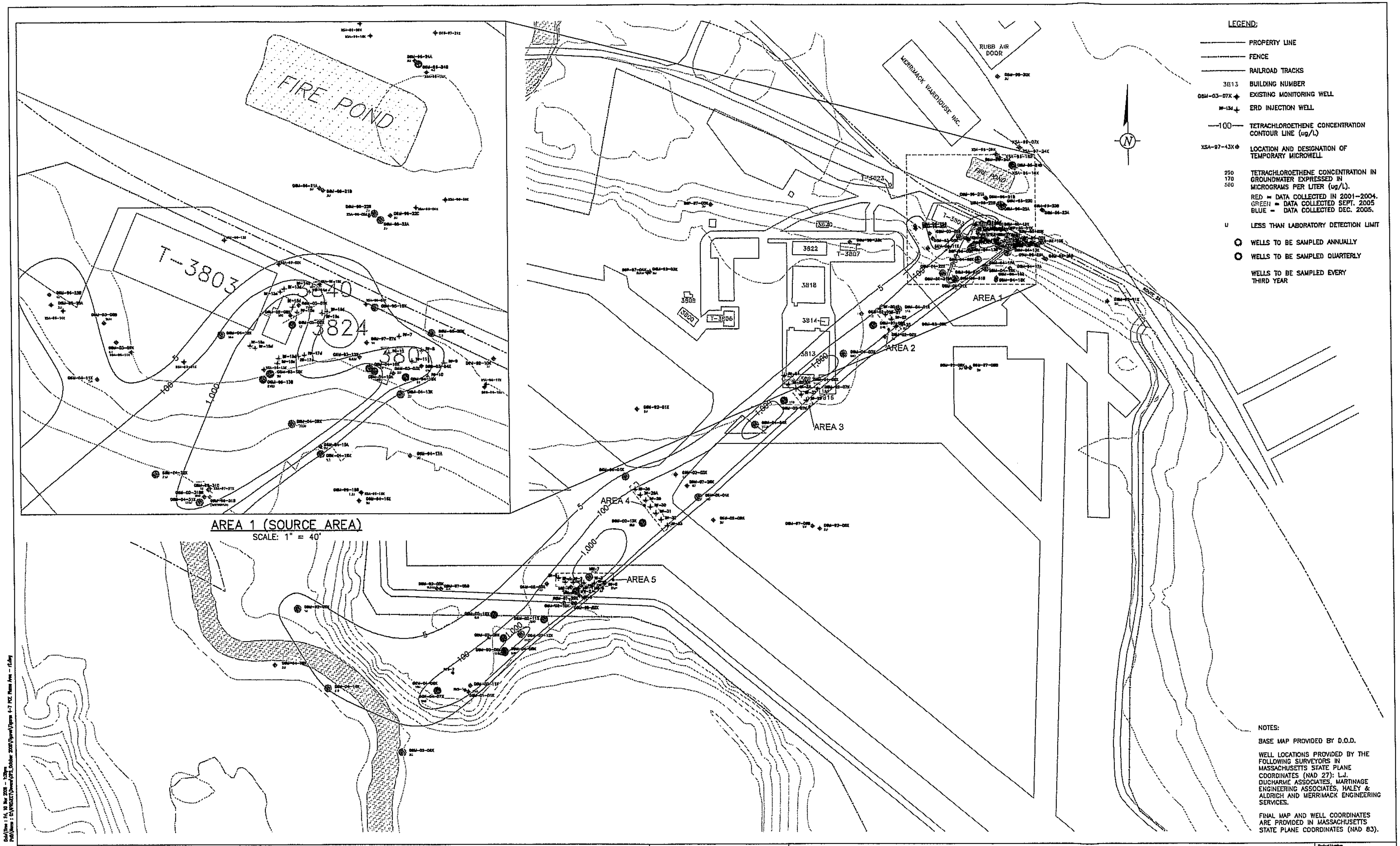
AOC 50
FORT DEVENS, MASSACHUSETTS

LIMITS OF LAND-USE CONTROL

Project Number
MA000664.0007

Date
02/28/05

Figure
3



LEGEND:

	PROPERTY LINE
	FENCE
	RAILROAD TRACKS
3813	BUILDING NUMBER
GBM-03-07X ✦	EXISTING MONITORING WELL
IW-15d +	ERD INJECTION WELL
—100—	TETRACHLOROETHENE CONCENTRATION CONTOUR LINE (ug/L)
XSA-97-43X ⊕	LOCATION AND DESIGNATION OF TEMPORARY MICROWELL
250 170 560	TETRACHLOROETHENE CONCENTRATION IN GROUNDWATER EXPRESSED IN MICROGRAMS PER LITER (ug/L). RED = DATA COLLECTED IN 2001–2004. GREEN = DATA COLLECTED SEPT. 2005 BLUE = DATA COLLECTED DEC. 2005.
U	LESS THAN LABORATORY DETECTION LIMIT
○	WELLS TO BE SAMPLED ANNUALLY
○	WELLS TO BE SAMPLED QUARTERLY
	WELLS TO BE SAMPLED EVERY THIRD YEAR

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

0 300
SCALE IN FEET

Area Manager	D. KNOX
Project Director	C. CASTELLUCCIO
Task Manager	C. CASTELLUCCIO
Technical Review	C. CASTELLUCCIO

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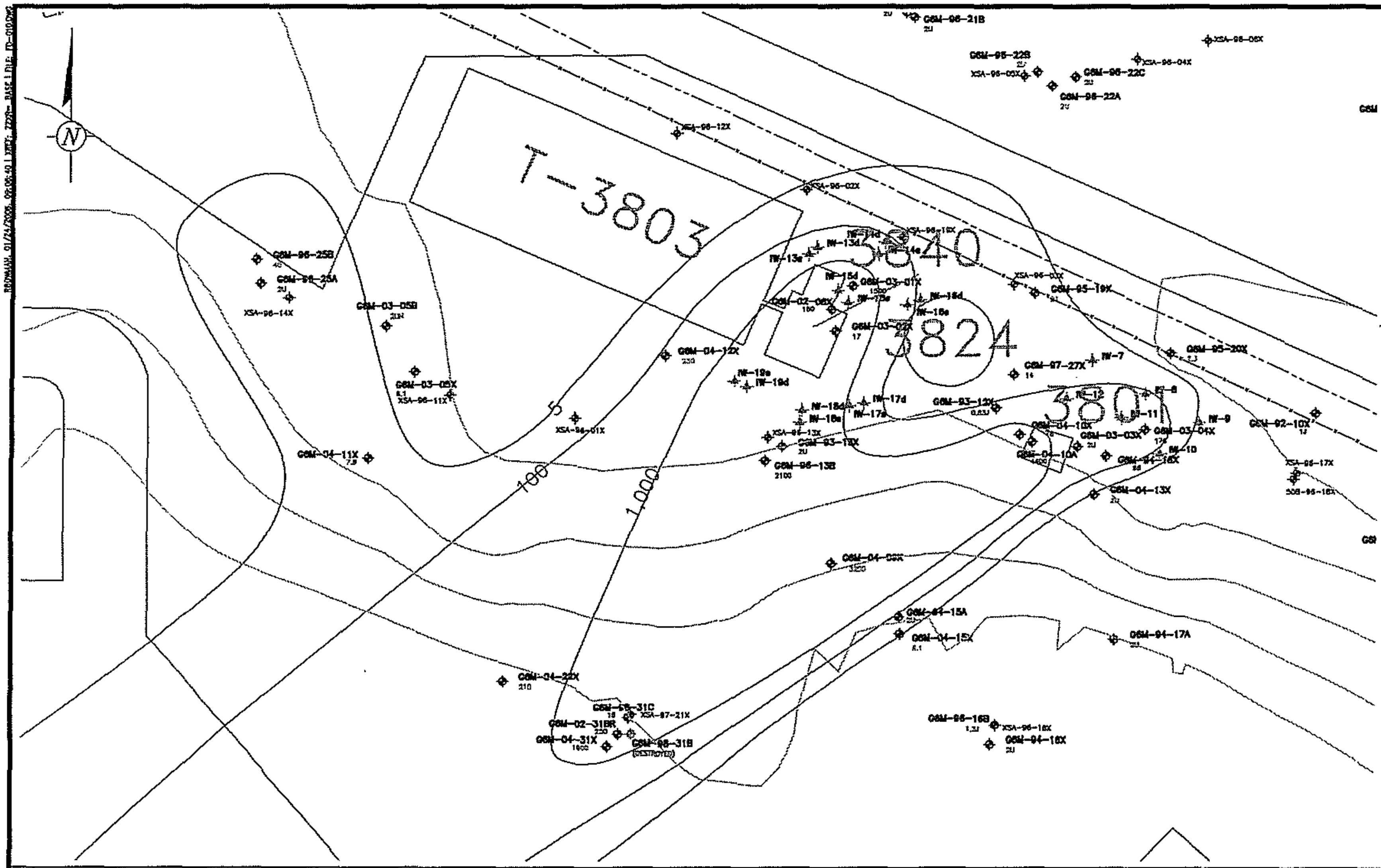
PCE CONCENTRATIONS DETECTED IN GROUNDWATER (MARCH 2006)

AOC 50
DEVENS, MASSACHUSETTS

Project Number	MA000664.0016
Date	06/13/06
Figure	4



LEGEND:

⌖ MONITORING WELL

45 PCE CONCENTRATION (MICROGRAMS PER LITER)

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

0 40
SCALE IN FEET

NO.	DATE	REVISION DESCRIPTION	BY / CKD

ARCADIS

PCE CONCENTRATIONS DETECTED IN
SOURCE AREA GROUNDWATER(MARCH 2006)

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER
C. CASTELLUCCIO

CHECKED BY
C. CASTELLUCCIO

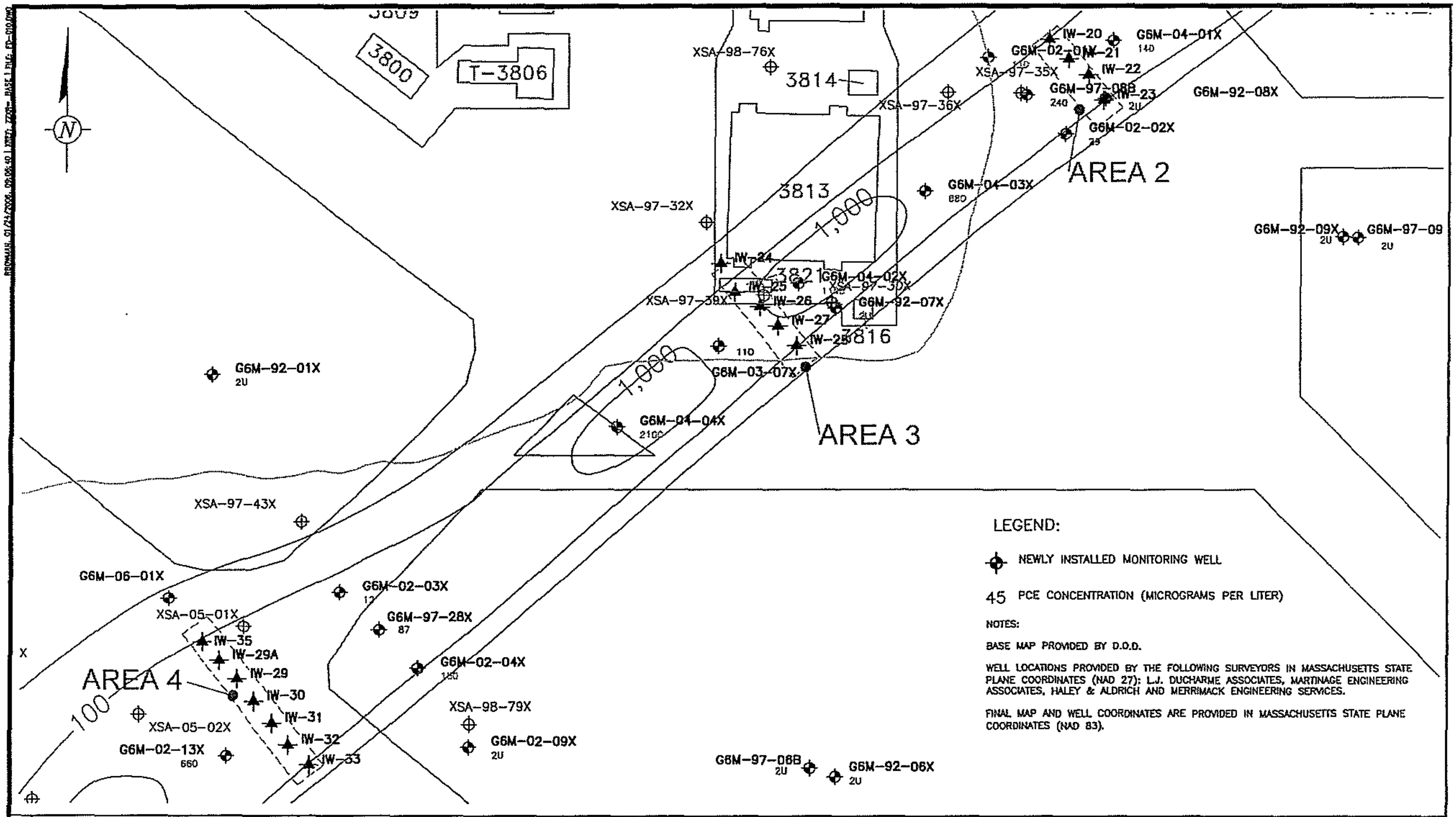
DRAWN BY
R. BOWMAN

DATE DRAWN
05/13/06

DRAWING NUMBER
PCE PLUME3

PROJECT NUMBER
MA000564.004A

FIGURE NUMBER
5



LEGEND:

⌖ NEWLY INSTALLED MONITORING WELL

45 PCE CONCENTRATION (MICROGRAMS PER LITER)

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

0 100
SCALE IN FEET

NO.	DATE	REVISION DESCRIPTION	BY	CKD

ARCADIS

PCE CONCENTRATIONS DETECTED IN
AREAS 2, 3 AND 4 (MARCH 2006)

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER
C. CASTELLUCCIO

CHECKED BY
C. CASTELLUCCIO

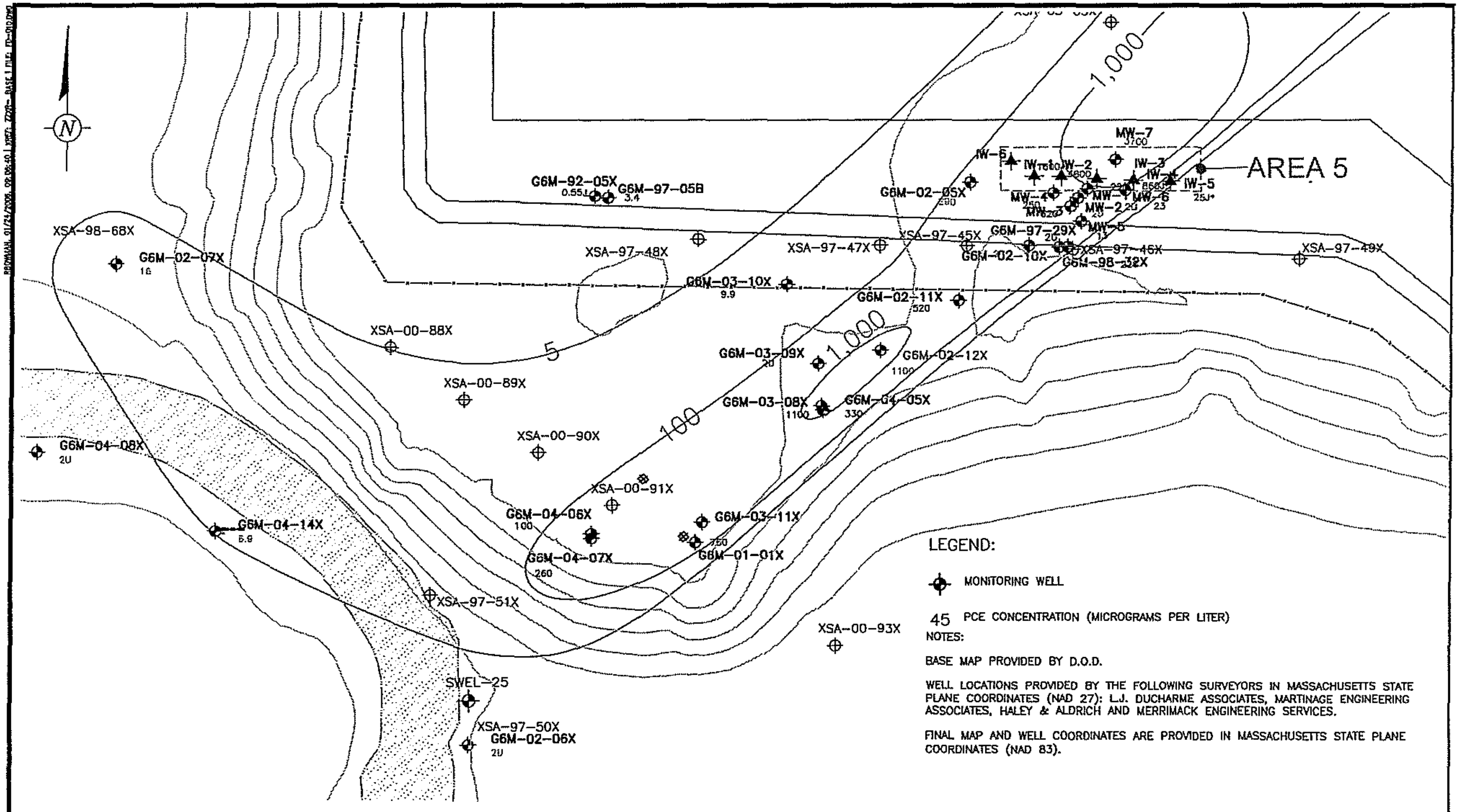
DRAWN BY
R. BOWMAN

DATE DRAWN
06/13/06

DRAWING NUMBER
PCE PLUMES

PROJECT NUMBER
MA000654.004A

FIGURE NUMBER
6



LEGEND:

⊕ MONITORING WELL

45 PCE CONCENTRATION (MICROGRAMS PER LITER)

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

0 100
SCALE IN FEET

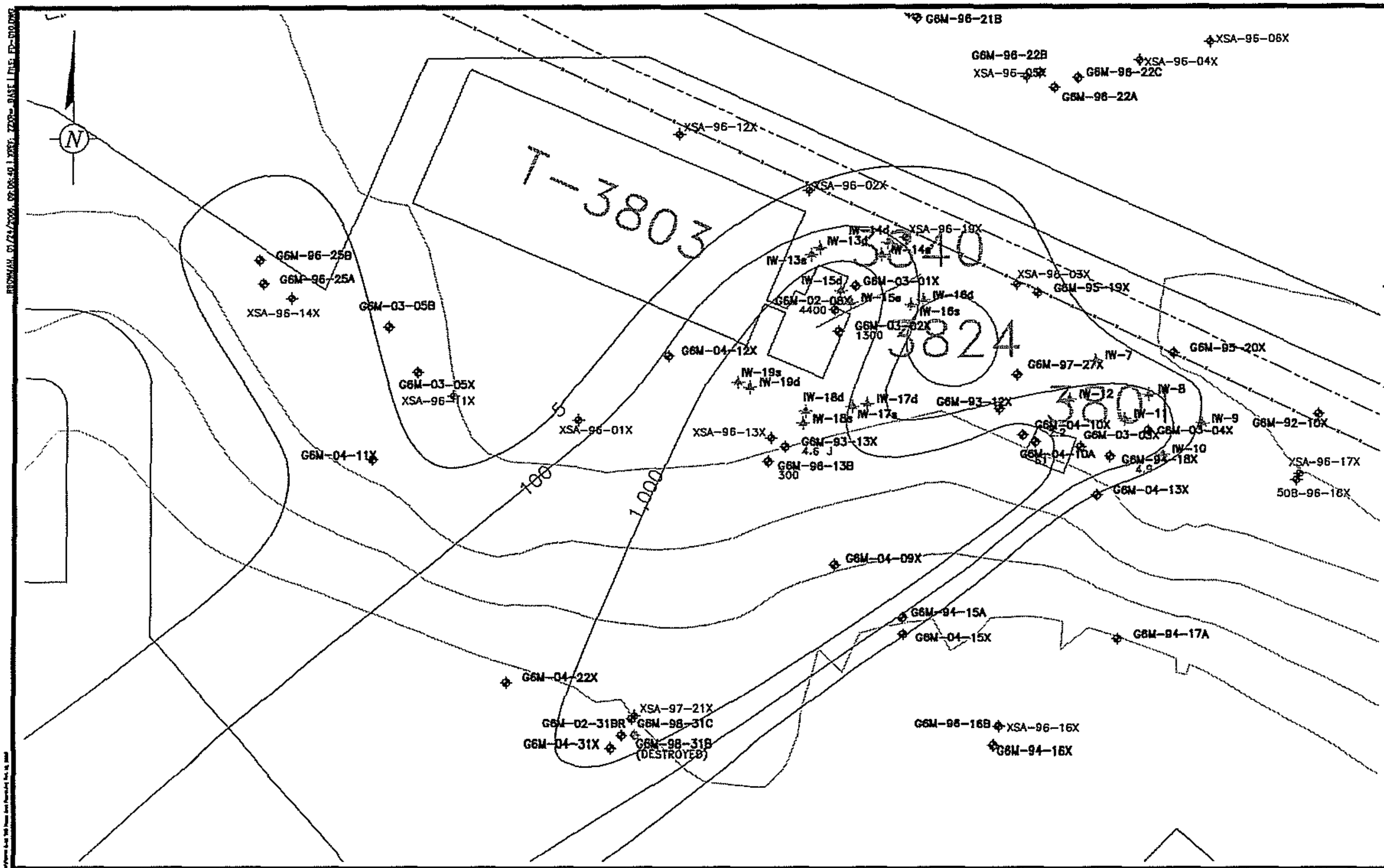
NO.	DATE	REVISION DESCRIPTION	BY	CKD

ARCADIS

PCE CONCENTRATIONS DETECTED IN
AREA 5 GROUNDWATER – MARCH 2006

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER C. CASTELLUCCIO	DRAWING NUMBER PCE PLUMES
CHECKED BY C. CASTELLUCCIO	PROJECT NUMBER MA000654.004A
DRAWN BY R. BOWMAN	FIGURE NUMBER 7
DATE DRAWN 06/13/06	



LEGEND:

⌖	MONITORING WELL
45	TOC CONCENTRATION (MILLIGRAMS PER LITER)
—	PCE CONCENTRATION ISOCONTOUR (MICROGRAMS PER LITER)

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

TOC CONCENTRATIONS PRESENTED ARE MOST RECENT DATA AVAILABLE.

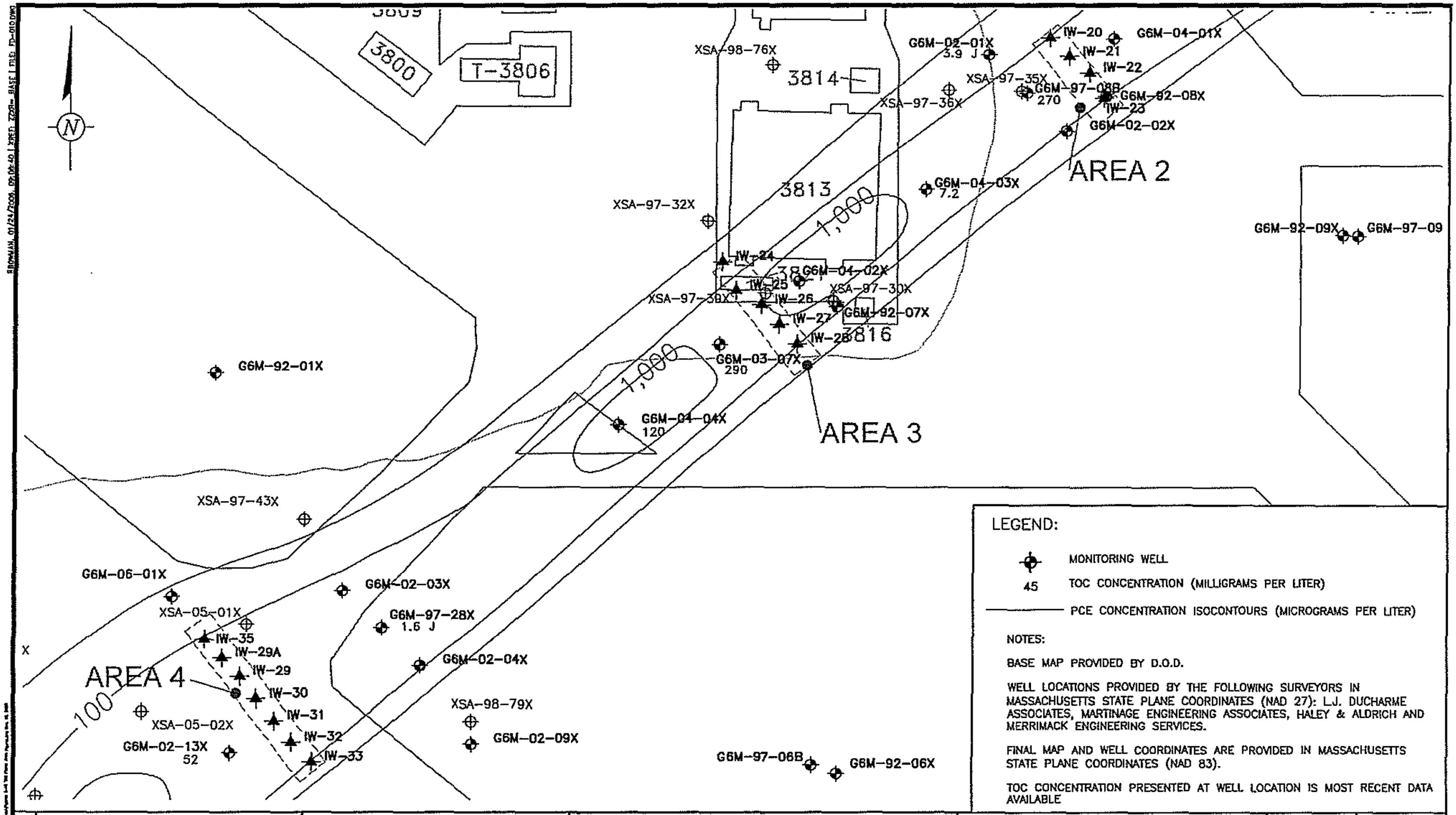
NO.	DATE	REVISION DESCRIPTION	BY	CKD

ARCADIS

TOC CONCENTRATIONS DETECTED IN
SOURCE AREA GROUNDWATER (MARCH 20

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER C. CASTELLUCCIO	DRAWING NUMBER PCE PLUME3
CHECKED BY C. CASTELLUCCIO	PROJECT NUMBER MA000664.0004A
DRAWN BY R. BOWMAN	FIGURE NUMBER 8
DATE DRAWN 06/13/06	



LEGEND:

⊕	MONITORING WELL
45	TOC CONCENTRATION (MILLIGRAMS PER LITER)
———	PCE CONCENTRATION ISOCONTOURS (MICROGRAMS PER LITER)

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

TOC CONCENTRATION PRESENTED AT WELL LOCATION IS MOST RECENT DATA AVAILABLE

0 100
SCALE IN FEET

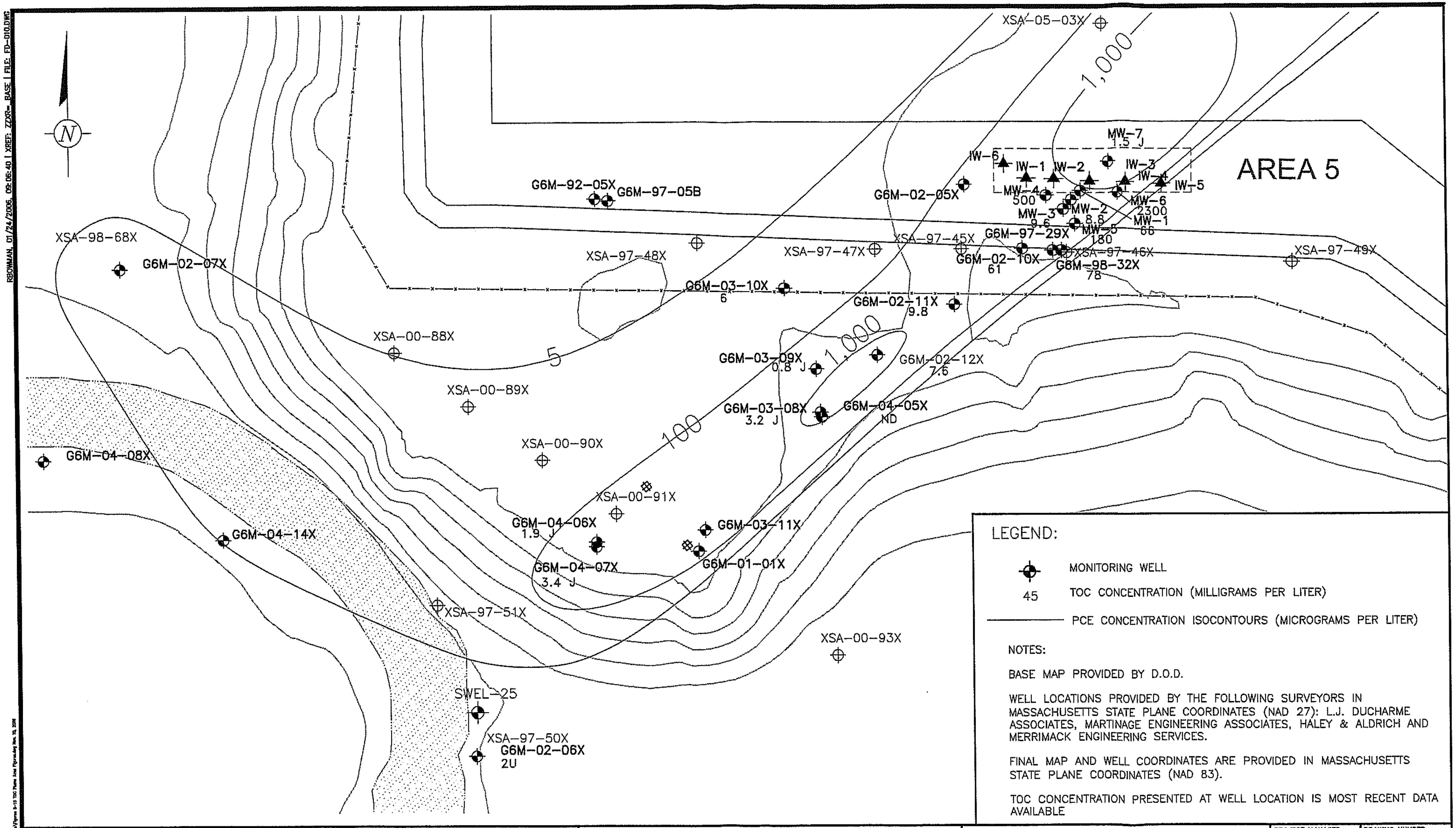
NO.	DATE	REVISION DESCRIPTION	BY	CKD

ARCADIS

TOC CONCENTRATIONS DETECTED IN
AREAS 2, 3 AND 4 (MARCH 2006)

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER C. CASTELLUCCIO	DRAWING NUMBER PCE PLUMES
CHECKED BY C. CASTELLUCCIO	PROJECT NUMBER MA000664.004A
DRAWN BY R. BOWMAN	FIGURE NUMBER 9
DATE DRAWN 06/13/06	



LEGEND:

⊕	MONITORING WELL
45	TOC CONCENTRATION (MILLIGRAMS PER LITER)
—	PCE CONCENTRATION ISOCONTOURS (MICROGRAMS PER LITER)

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

TOC CONCENTRATION PRESENTED AT WELL LOCATION IS MOST RECENT DATA AVAILABLE

0 100
SCALE IN FEET

NO.	DATE	REVISION DESCRIPTION	BY	CKD

ARCADIS

TOC CONCENTRATIONS DETECTED IN
AREA 5 GROUNDWATER (MARCH 2006)

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER
C. CASTELLUCCIO

CHECKED BY
C. CASTELLUCCIO

DRAWN BY
R. BOWMAN

DATE DRAWN
06/13/06

DRAWING NUMBER
PCE PLUME3

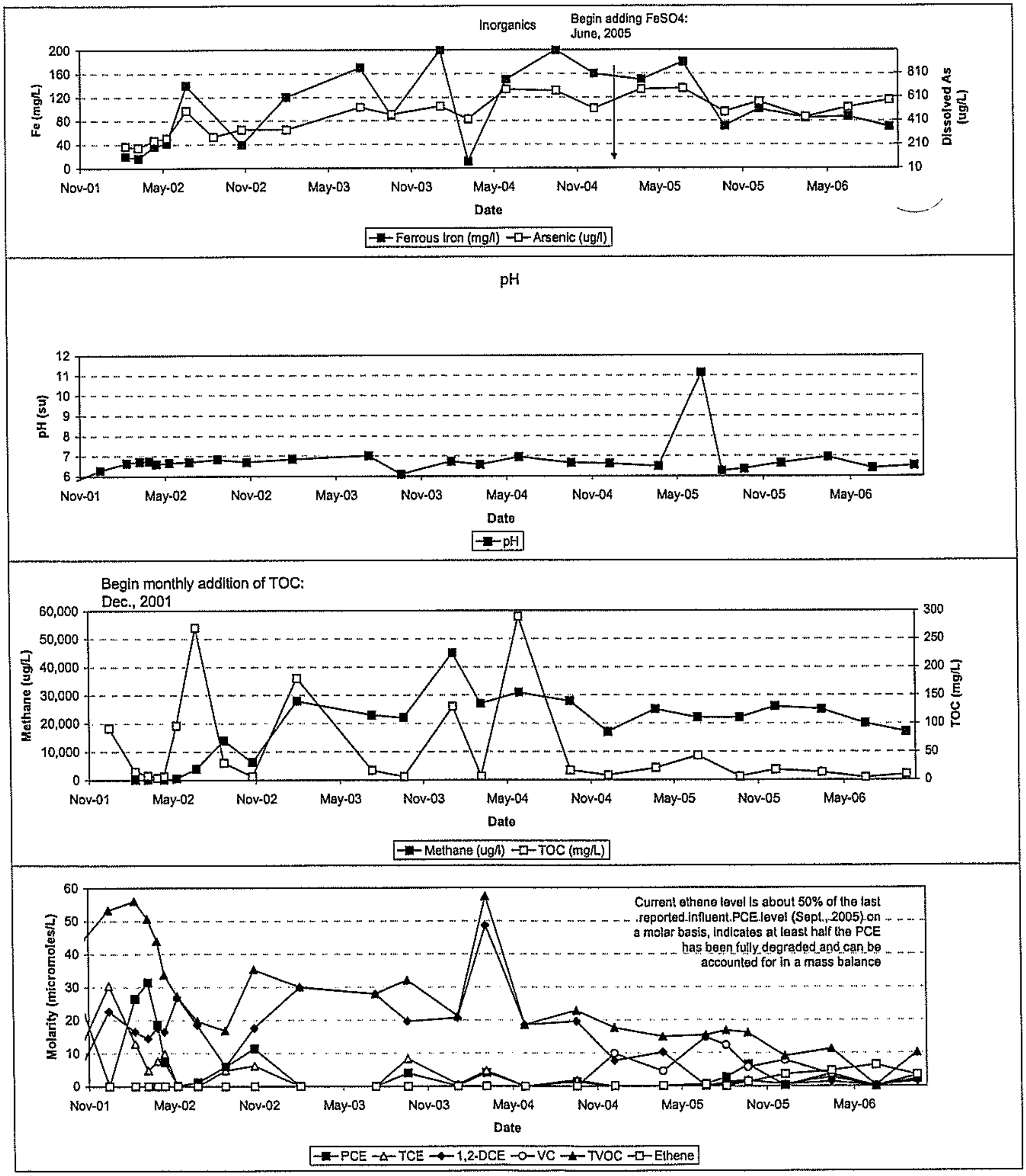
PROJECT NUMBER
MA000664.004A

FIGURE NUMBER
10

RBOWMAN, 01/24/2006, 09:06:40 | XREF: ZZXR= BASE | FILE: FD-010.DWG

Figure 11. ERD Area 5 Monitoring Data

MW-3, 40 feet downgradient
AOC 50, Devens Massachusetts


Inorganics

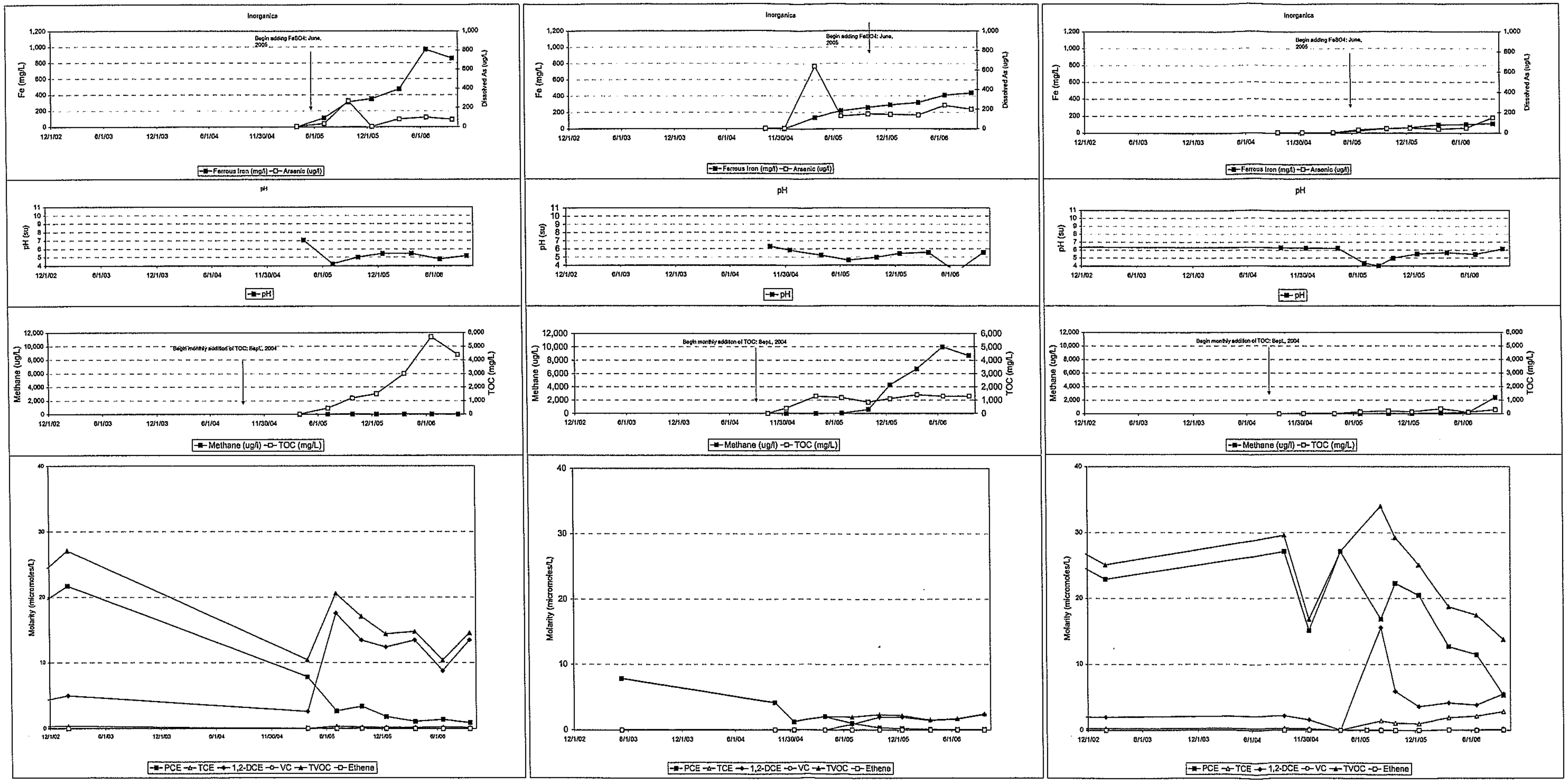
Begin adding FeSO4: June, 2005

pH

Begin monthly addition of TOC: Dec., 2001

Current ethene level is about 50% of the last reported influent PCE level (Sept., 2005) on a molar basis, indicates at least half the PCE has been fully degraded and can be accounted for in a mass balance

Figure 12. ERD Area FDW-NE Monitoring Data



G6M-02-08X, 10 feet downgradient
AOC 50, Devens Massachusetts

G6M-03-02X, 15 feet downgradient
AOC 50, Devens Massachusetts

G6M-96-13B, 25 feet downgradient
AOC 50, Devens Massachusetts

Figure 13. ERD Area FDSA Monitoring Data

G6M-04-10A, 23-feet Downgradient
AOC 50, Devens Massachusetts

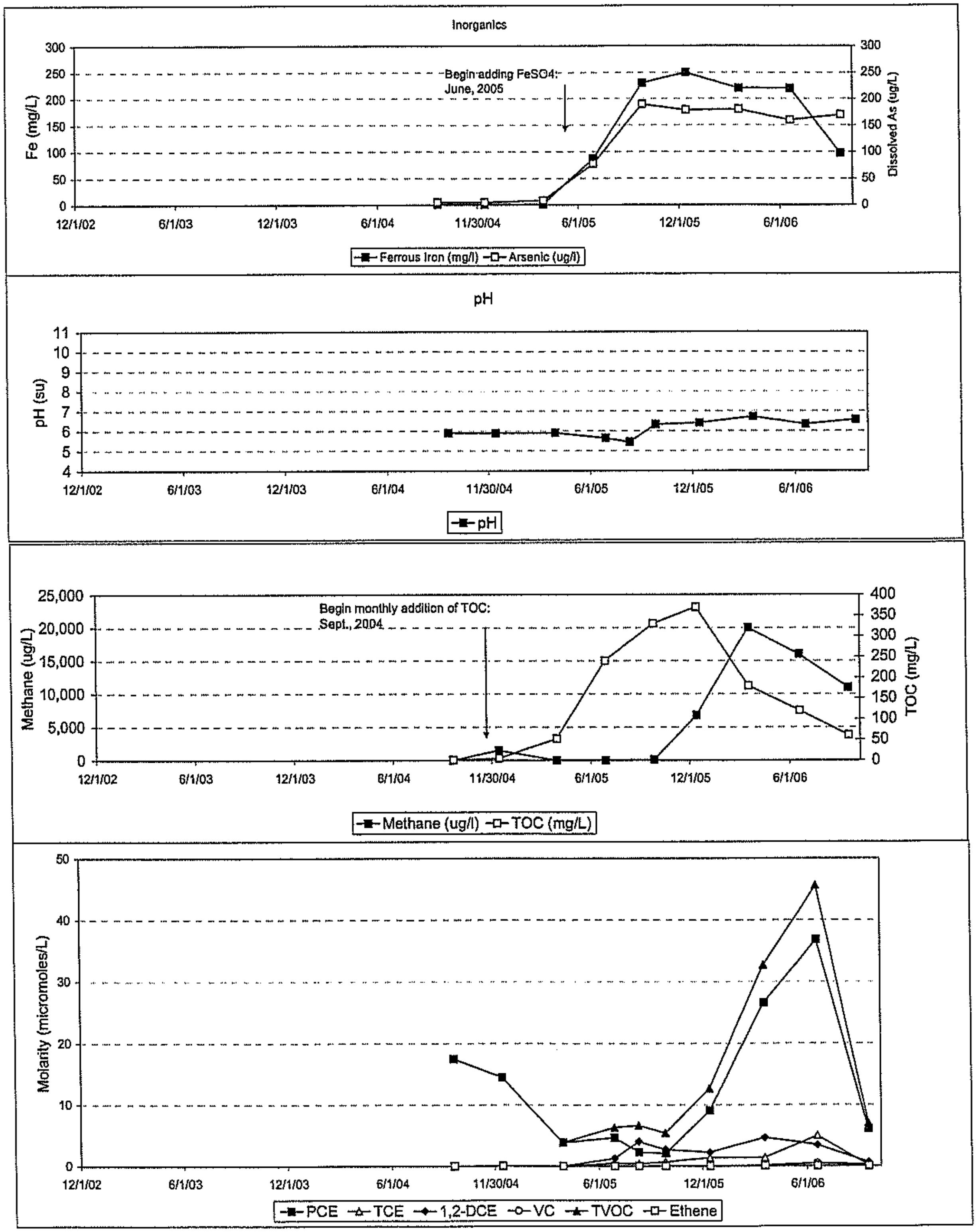


Figure 14. ERD Area 2 Monitoring Data

G6M-97-08B, 60-feet downgradient
AOC 50, Devens Massachusetts

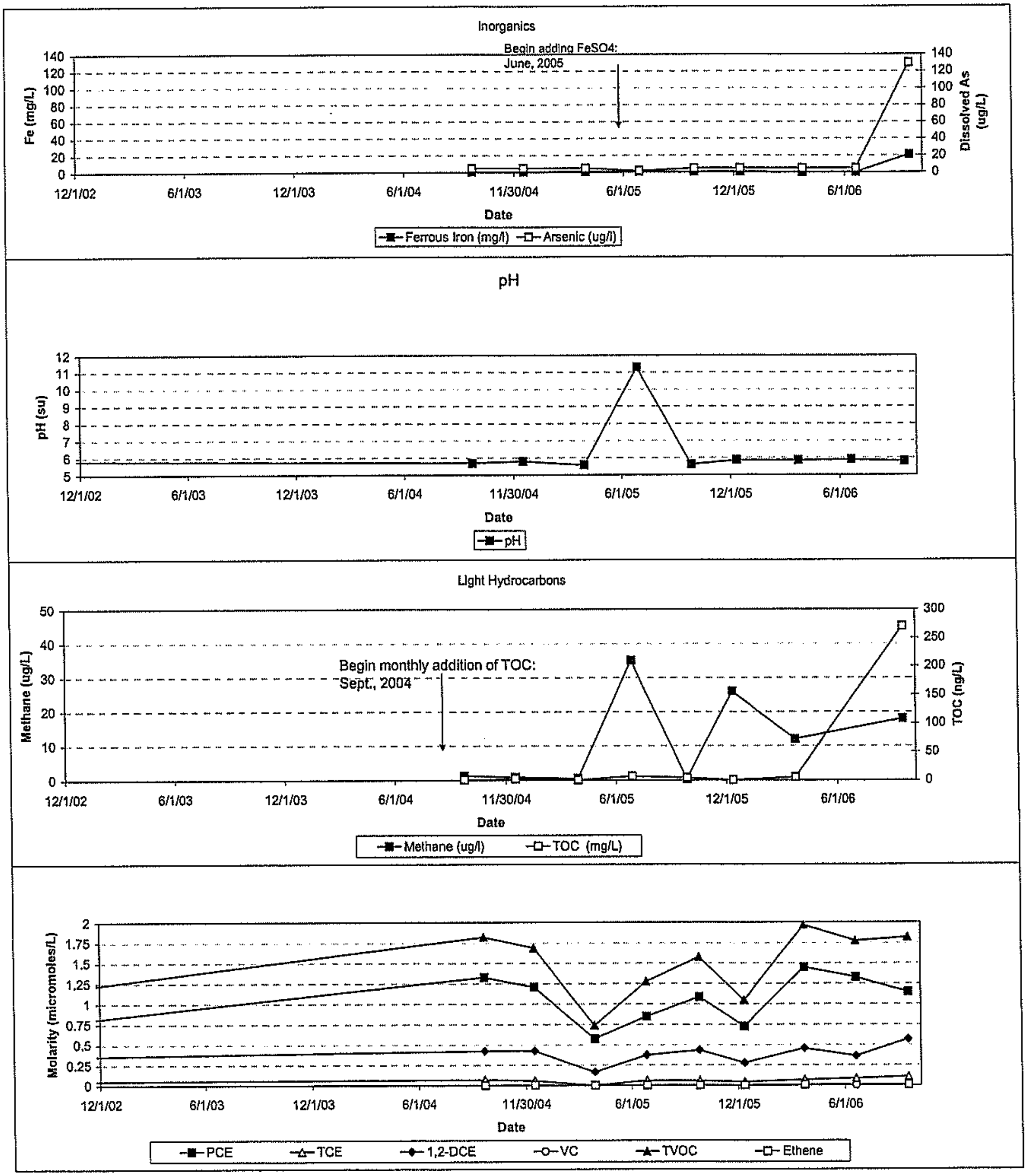


Figure 15. ERD Area 3 Monitoring Data

G6M-03-07X, 60-feet downgradient

AOC 50, Devens Massachusetts

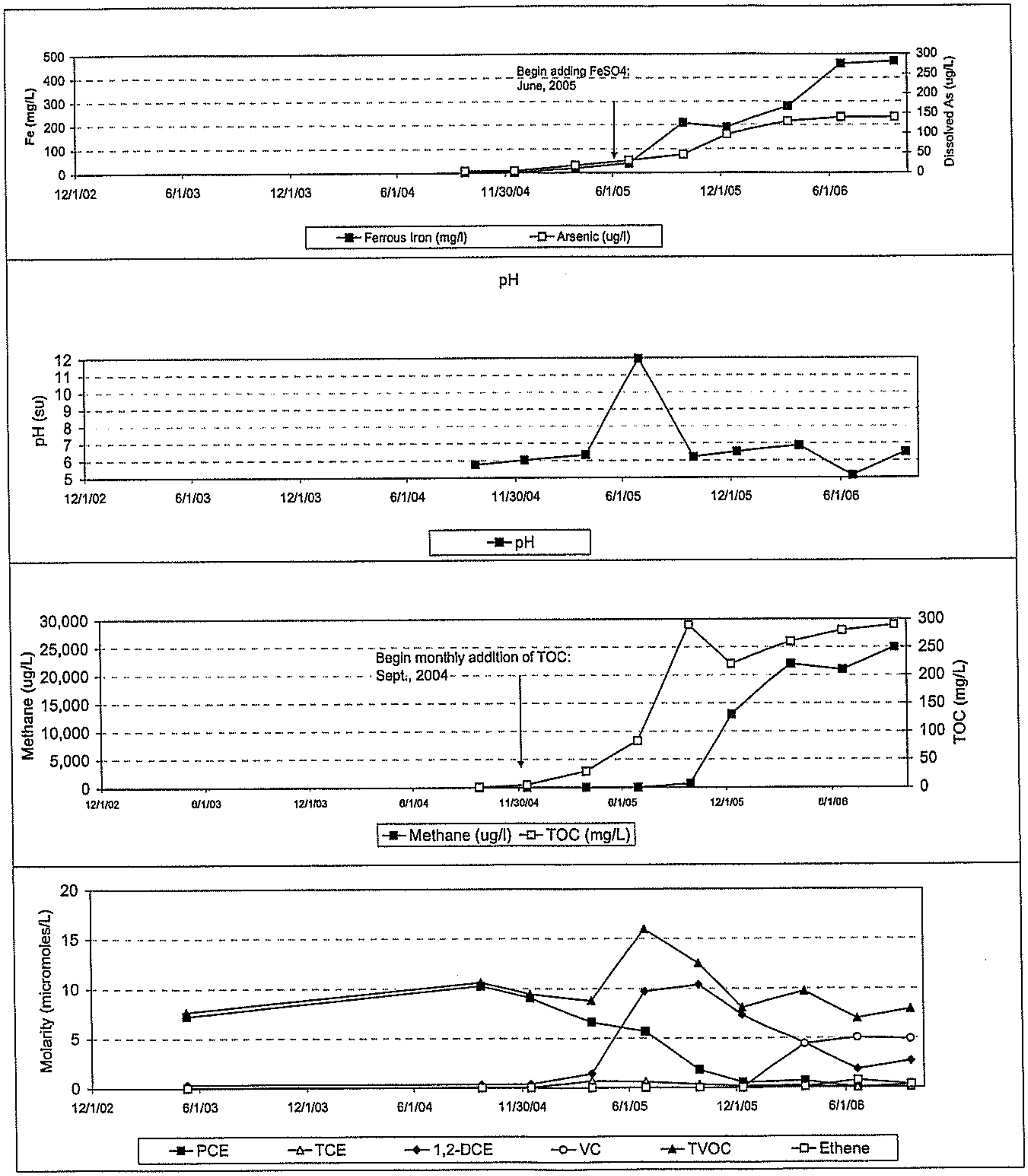


Figure 16. ERD Area 4 Monitoring Data

G6M-02-13X, 60-feet downgradient

AOC 50, Devens Massachusetts

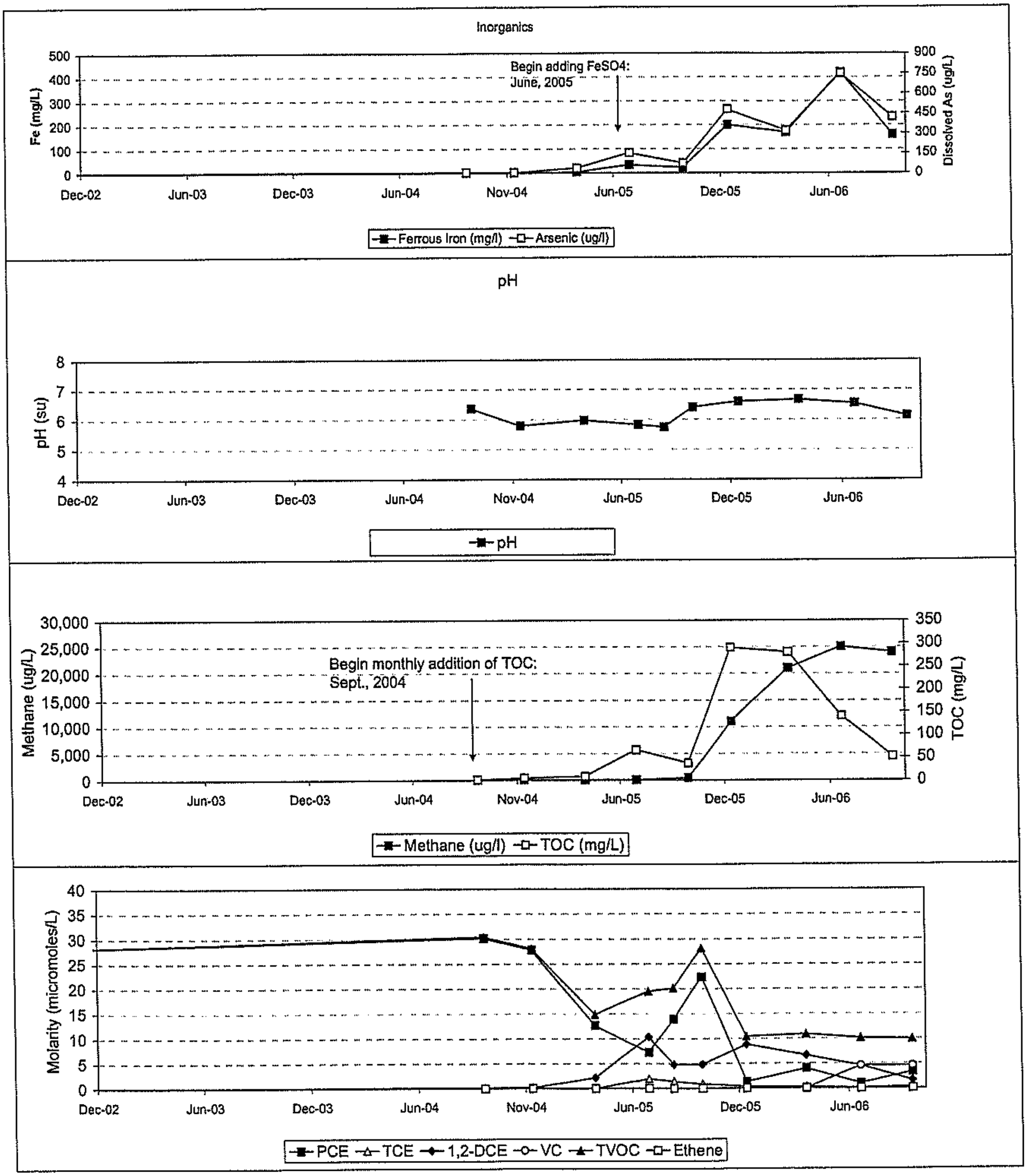


Figure 17. Iron and Arsenic Concentrations and Ratios Within and Downgradient of the Area 5 ERD Reactive Zone

AOC 50, Devens, Massachusetts

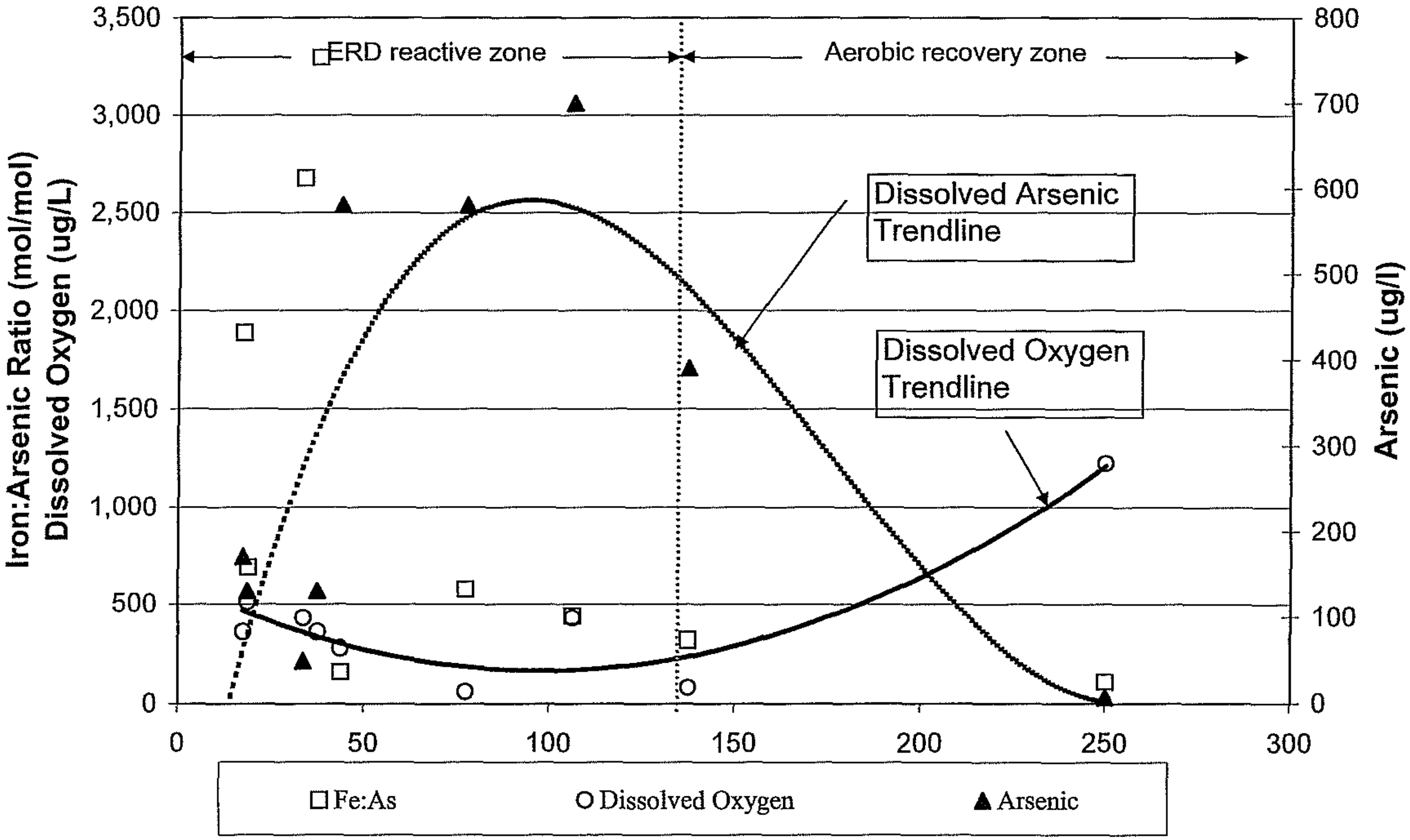


Figure 18. Ferrous Iron to Arsenic Ratio in Sitewide Downgradient ERD Monitoring Wells

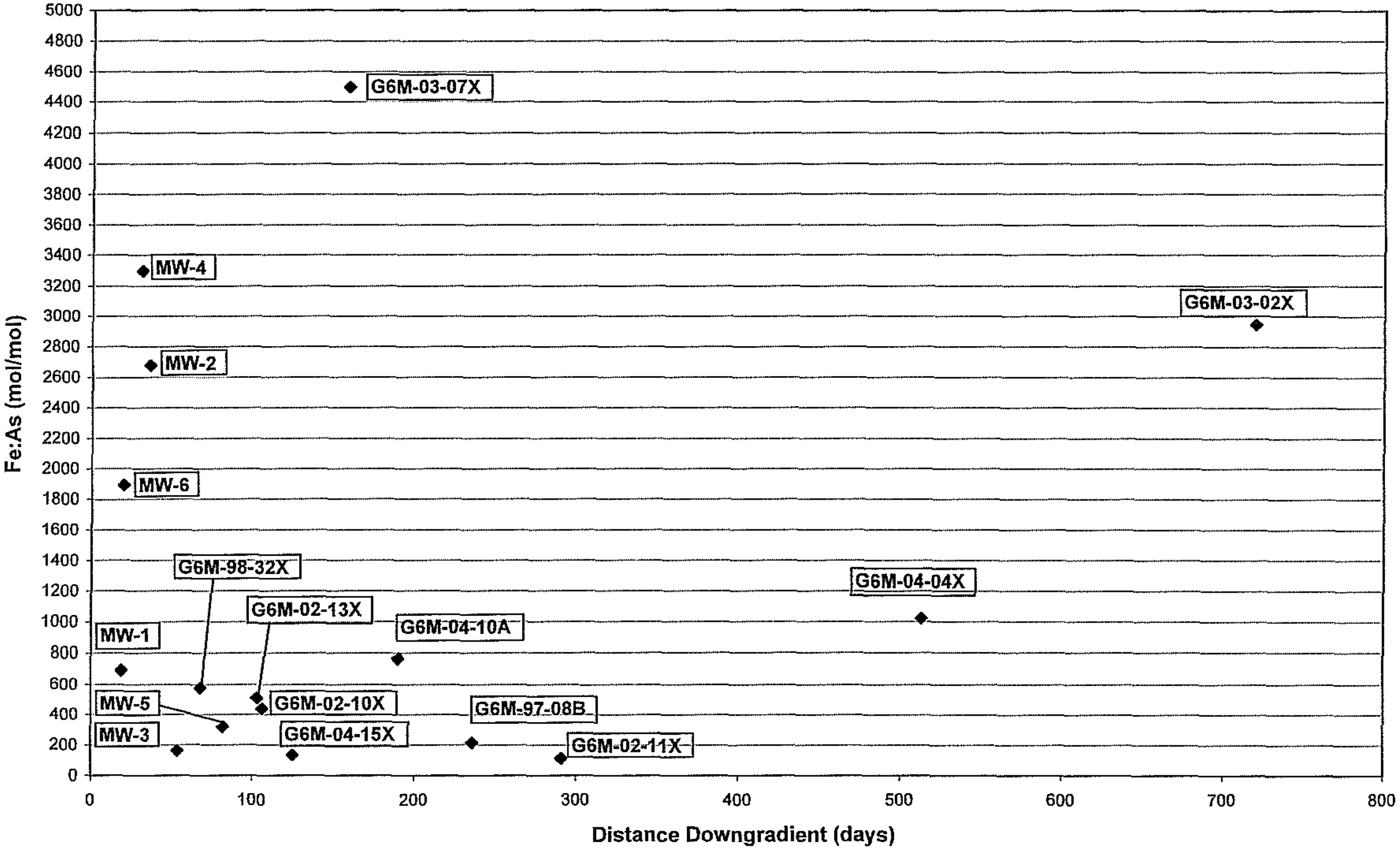
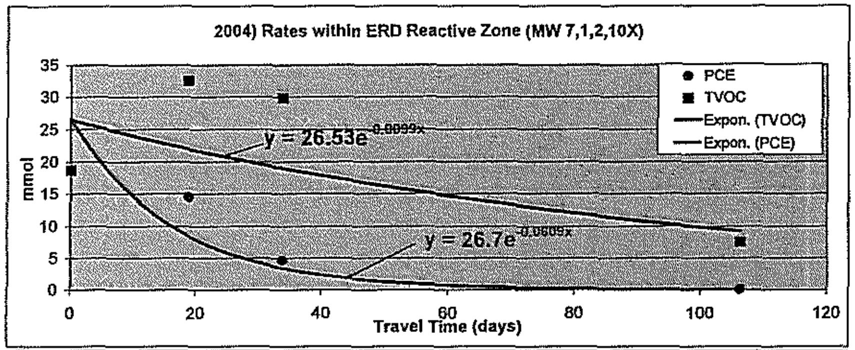
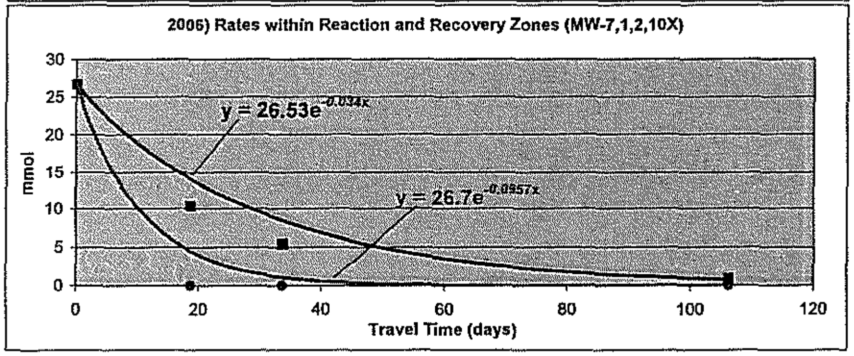
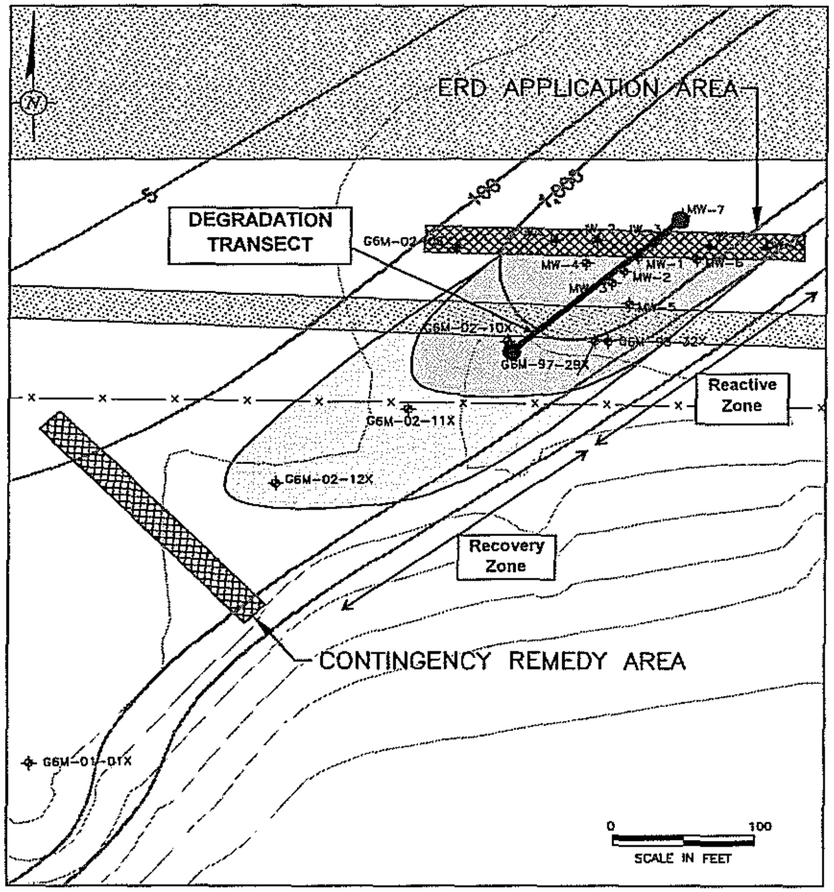


Figure 19. PCE and TVOC ERD Degradation Rates in Area 5 Well Locations

Wells	Transect Length (ft)	Degradation Rate[1] PCE (mmol/day)	Degradation Rate[1] TVOC (mmol/day)	Half Life[2] PCE (day)	Half Life[2] TVOC (day)
Groundwater Model Predictions	–	–	–	25	75
2004) MW-7, MW-1, MW-2, G6M-02-10X	130	0.0609	0.0099	11.4	70.0
2005) MW-7, MW-1, MW-2, G6M-02-10X	130	0.0957	0.0340	7.2	20.4


2004) Rates within ERD Reactive Zone (MW 7,1,2,10X)

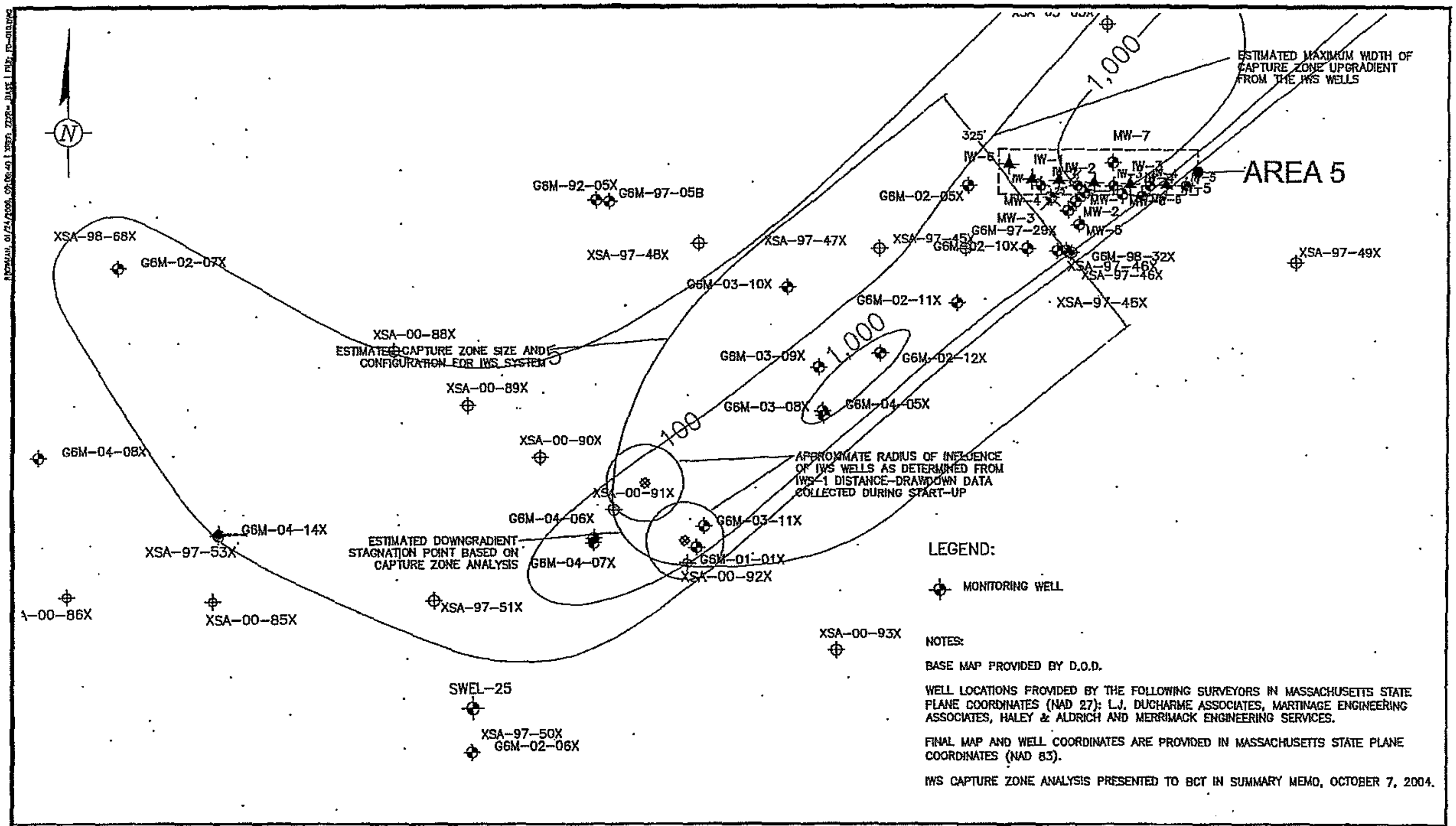

2005) Rates within Reaction and Recovery Zones (MW-7,1,2,10X)



Notes:

[1] Degradation rate is equivalent to the -k variable in the formula attached at right: $\boxed{C = C_o \times e^{-kt}}$

[2] Half lives were calculated with the following relationship ($T_{1/2}$): $\boxed{T_{1/2} = \frac{\ln(C_{1/2})}{-k}}$



LEGEND:

⊕ MONITORING WELL

NOTES:

BASE MAP PROVIDED BY D.O.D.

WELL LOCATIONS PROVIDED BY THE FOLLOWING SURVEYORS IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 27): L.J. DUCHARME ASSOCIATES, MARTINAGE ENGINEERING ASSOCIATES, HALEY & ALDRICH AND MERRIMACK ENGINEERING SERVICES.

FINAL MAP AND WELL COORDINATES ARE PROVIDED IN MASSACHUSETTS STATE PLANE COORDINATES (NAD 83).

IWS CAPTURE ZONE ANALYSIS PRESENTED TO BCT IN SUMMARY MEMO, OCTOBER 7, 2004.

NO.	DATE	REVISION DESCRIPTION	BY CKD

ARCADIS

IWS SYSTEM CAPTURE ZONE

AOC 50
DEVENS, MASSACHUSETTS

PROJECT MANAGER C. CASTELLUCCIO
CHECKED BY C. CASTELLUCCIO
DRAWN BY K. BOWMAN
DATE DRAWN 06/13/05
DRAWING NUMBER PCE PLUMES
PROJECT NUMBER MA000634.004A
FIGURE NUMBER 20

APPENDIX A

PARCEL # A5

A certain parcel of land located in the Town of Ayer, Middlesex County Massachusetts, known as Lease Parcel A5 located on the easterly side of the main gate and the southerly side of Rt. 2A, beginning at a point with the NAD coordinates (± 50feet) N3035200, E628080.

- Thence running along the southerly side of Rt. 2A S-64° -54'E, eight hundred and twenty five feet ±, (825'±) to a point;
- Thence S23° -54'W, one hundred and eighty feet ±, (180' ±) to a point;
- Thence N61° -30'W, three hundred and eighty five feet ±, (385' ±) to a point;
- Thence S70° -12'W, one hundred and fifty five feet ±, 155 ±) to a point;
- Thence N62° -27'W, three hundred and two feet ±, (302' ±) to a point;
- Thence N27° -40'W, one hundred and ninety seven feet ±, (197'±) to a point;
- Thence N66° -48'E, one hundred and eighty feet ±, (180' ±) to the point of beginning;

Said Parcel contains 188,330 square feet ± or 4.3 acres ±. Said Parcel also contains building #3803

LEASE IN FURTHERANCE OF CONVEYANCE

OF REAL PROPERTY AND FACILITIES ON

THE FORT DEVENS, MASSACHUSETTS,

MILITARY RESERVATION

EXHIBITS

Exhibit Number	Title		
A	Lease Premises		
B	Memorandum of Agreement	-	Delivered at Closing
C	Survey of Condition	-	Delivered at Closing

Department of the Army for the purchase of portions of the property that formerly comprised Fort Devens; and

WHEREAS, the Army, as authorized by the Base Closure Law, has determined that the Land Bank's application meets the criteria for conveyance to assist economic development and has accepted the application; and an offer to purchase/sell has been negotiated and accepted by Army and the Land Bank, in a Memorandum of Agreement (the MOA), dated May 9, 1996, regarding the transfer to the Land Bank of certain portions of Fort Devens not being retained by the Army or transferred to federal agencies, for the purpose of implementing the Reuse Plan; and

WHEREAS, due to the ongoing environmental cleanup and the unexploded ordnance (UXO) clearance process at Fort Devens being undertaken by the Army, in order to implement the intentions of the Army and the Land Bank as set forth in the MOA, certain parcels will be leased rather than conveyed pending completion of the environmental cleanup and UXO clearance by the Army, said parcels being more particularly described in Exhibit A, hereinafter referred to as the "Lease Premises."

WHEREAS, as soon as a Finding of Suitability to Transfer (FOST) is executed by the Army for the Leased Premises, or a portion of said Leased Premises, and said Leased Premises may be conveyed consistent with the requirements of the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. 9620 (h), as amended, and other legal and policy requirements, the Secretary of the Army intends to convey the same to the Land Bank by one or more quitclaim deeds, as provided for in the MOA, and the Land Bank agrees to accept such conveyance(s) as soon as the above-referenced conditions are met; and

Army Corps of Engineers, New England Division, Frederick C. Murphy Federal Building, 424 Trapelo Road, Waltham, MA 02254-9149, and THE GOVERNMENT LAND BANK (Land Bank), a Massachusetts body corporate and politic created by Chapter 212 of the Acts of 1975, as amended, having its principal office at 75 Federal Street, 10th Floor, Boston, Massachusetts 02110.

THIS LEASE is granted subject to the following terms and conditions:

ARTICLE 1

LEASE; LEASE TERM; USE OF LEASE PREMISES

1.01 To have and to hold for a term commencing May 9, 1996 and ending on May 9, 2046 (Lease Term), unless sooner terminated or conveyed in fee pursuant to the terms hereof or of the Memorandum of Agreement between the United States of America and the Government Land Bank for the Conveyance of Fort Devens, Massachusetts, dated May 9, 1996 (MOA), attached as Exhibit B, the Army hereby leases to the Land Bank, and the Land Bank hereby leases from the Army, the Lease Premises (Exhibit A herein), including all buildings, facilities and improvements thereon and rights appurtenant thereto. If due to default by the Land Bank or termination of the MOA, the Land Bank is not entitled to conveyance of the Leased Premises at the time the Army is able to convey in fee, then the Lease shall terminate on the date of execution of a Finding of Suitability to Transfer (FOST) by the Army with respect to that portion of the Leased Premises covered by the FOST. The Lessor reserves the use and occupancy of the following buildings, including all facilities and areas currently used by the Lessor in connection therewith, and the right of ingress and egress thereto, until July 10, 1997: T-204, ASP include successors and assigns, and their duly authorized representatives.

ARTICLE 2
RENT

2.01 The Land Bank shall provide the Army as rent (Rent) hereunder, (a) protection, repair and maintenance of, and assumption of sole operating responsibility for the Lease Premises, except with regard to Army operations undertaken in furtherance of or related to the environmental clean-up or UXO clearance of the Lease Premises, and (b) payment of utility charges, as provided in the Utilities Agreement contained in the MOA. The Land Bank agrees that monetary rent received by the Land Bank from any Sublessee of the Land Bank under this Lease will be applied to costs incurred by the Land Bank for protection, maintenance, operation, repair and improvement of the Lease Premises, as may be necessary to cover such costs.

ARTICLE 3
CONDITION OF LEASE PREMISES; REPAIRS; UTILITIES; HISTORIC PRESERVATION

3.01 The Land Bank has inspected and knows and accepts the condition and state of repair of the Lease Premises. It is understood and agreed that the Lease Premises are leased in an "as is," "where is" condition, without any representation or warranty by the Army concerning the state of repair or condition of the Lease Premises, and without obligation on the part of the Army to make any alterations, repairs or additions, except as may be specifically provided herein. The Land Bank acknowledges that expense. The Land Bank shall exercise due diligence in the protection of all property located on the Leased Premises against fire, casualty, or damage from any and all causes, excepting: (i) reasonable wear and tear, (ii) alterations, construction, site preparation or demolition undertaken pursuant to Article 12; and (iii) alterations or damage done in conjunction with environmental remediation or UXO clearance activities conducted by the Army or its contractors. For any Leased property that is not conveyed to the Land Bank upon termination or expiration of this lease; is not covered by the above exceptions; and that is damaged or destroyed by the Land Bank without written permission of the Army; the Land Bank shall be repair or replace said property to the reasonable satisfaction of the Army; or, in lieu of such repair or replacement, the Land Bank shall, at the Army's election, pay to the Army money in an amount sufficient to compensate for the loss sustained by the Army by reason of said damages or destruction. It is understood and agreed by the parties, however, that portions of the Lease Premises, as determined by the Land Bank, may be maintained at the minimal level necessary to prevent deterioration and diminution of value, pending reuse thereof by the Land Bank.

3.04 The Land Bank shall provide, at its sole cost and expense, janitorial, building maintenance and repair and grounds maintenance services at the Lease Premises, as may be required by the Land Bank in the operation of the Lease Premises.

3.05 In accordance with and if authorized by the Utilities Agreement contained in the MOA, the Land Bank may request, and the Army shall provide to the Lease Premises, electricity, natural gas, water, sewer, and telephone services, on a reimbursable basis during the period that the Army retains operation of said systems. Furthermore, if the Land Bank obtains administrative departments, bureaus and officials and of the Devens Enterprise Commission established pursuant to Chapter 498 of the Massachusetts Acts of 1993, as amended. The Land Bank shall pay all costs, expenses, claims, fines, penalties and damages that may in any manner arise out of or be imposed because of the failure of the Land Bank to comply with said laws. The provisions of this paragraph shall (a) in no way compromise the Army's obligation under applicable legal requirements to complete the environmental clean-up of the Lease Premises or the clearance of UXO thereon, or to indemnify the Land Bank, as provided for in the MOA; (b) not obligate the Land Bank to complete the environmental clean-up of the Lease Premises being undertaken by the Army as required under CERCLA, the National Contingency Plan (NCP), the FFA, the MOA, and deeds from the Army to the Land Bank.

ARTICLE 5

INDEMNIFICATION OF THE ARMY

5.01 The indemnification provided by the Land Bank to the Army under this Article 5 is subject to the indemnification provided by the Army to the Land Bank under Article 5 of the MOA and in the event of conflict or inconsistency between the provisions of Article 5 of this Lease and said provisions of Article 5 of the MOA, said provisions of Article 5 of the MOA shall control.

5.02 The Army shall not be responsible for damages to property or injuries or death to persons which may arise from or be attributable or incident to the condition or state of repair of the Lease Premises, or the use and occupation of them, or for damages to the property of the Land Bank, or for damages to the property or injuries or death to the person of the Land Bank's give the Land Bank notice of any claim against it covered by this indemnity as soon after learning of such claim as practicable.

5.04 The Land Bank shall indemnify and hold harmless the United States from any costs, expenses, liabilities, fines, or penalties resulting from discharges, releases, emissions, spills, storage, disposal, or any other action by the Land Bank giving rise to United States liability, civil or criminal, or responsibility under Federal, state or local environmental laws.

5.05 This Article 5 and the obligations of the Land Bank hereunder shall survive the expiration or termination of the lease and the conveyance of the Leased Premises to the Land Bank. The Land Bank's obligation hereunder shall apply whenever the United States incurs costs or liabilities for the Land Bank's actions giving rise to liability under this Article.

ARTICLE 6

ASSIGNMENT; SUBLETTING

6.01 Without the prior written consent of the Army through the Corps of Engineers, New England Division, the Land Bank shall not sublease, license, or grant any interest under this lease, except as provided for in Article 9 (Mortgaging). The Army's consent shall not be unreasonably withheld or delayed and shall be deemed granted if a response is not received by the Land Bank within twenty-one (21) days of the receipt by the Army of a written request for consent. Every sublease shall specifically identify and require compliance with the Environmental Protection provisions set out in Article 16 of this Lease and shall state that it is subject to the terms and conditions of this lease and that, in case of any conflict between the instruments, this lease may be taxed, assessed or imposed upon the Property or interest of the Land Bank with respect to or upon the Lease Premises.

ARTICLE 8
DEFAULTS

8.01 The following shall be deemed a default by either the Army or the Land Bank and a breach of the Lease: a party's failure to observe or perform any of its obligations under the terms, covenants or conditions of the Lease, which failure persists after the expiration of ninety (90) days from the date the aggrieved party gives written notice to the party calling attention to the existence of that failure. However, if the default is one relating to a matter that exposes occupants or the public to an imminent danger to safety or health of which the public authorities have given due notice to the party, then such shorter notice to the party, whether written or otherwise, shall be sufficient notice of default under this Lease.

8.02 In the event of a default, as provided in 8.01, the aggrieved party may, at its option, following the expiration of applicable notice and grace periods: (a) seek injunctive relief, monetary damages, or both; (b) take such measures as the aggrieved party deems reasonable to mitigate the effects of or cure such default, and assess all costs incurred for such mitigation to the defaulting party; (c) terminate this Lease; or (d) avail itself of any combination of said remedies.

8.03 Any action taken by either party under this Article 8 shall not waive any right that the party would otherwise have against the other party who shall remain responsible for any loss and damage suffered by reason of the default or breach.

ARTICLE 9

MORTGAGING

9.01 The Land Bank or any Sublessee may make a mortgage or mortgages on its interest in the Lease. The provisions of this Article 9 shall be fully applicable to Sublessees of the Land Bank.

9.02 If the Land Bank shall have made any mortgage (sometimes referred to as a Leasehold Mortgage) and if a Leasehold Mortgagee (the holder of any Leasehold Mortgage) shall have given to the Army a notice (Leasehold Mortgagee's Notice) specifying the name and address of the Leasehold Mortgagee, the Army shall give to the Leasehold Mortgagee a copy of each notice of default by the Land Bank at the same time as and whenever any such notice of default shall thereafter be given by the Army to the Land Bank, addressed to the Leasehold Mortgagee at the address last furnished to the Army. No notice of default by the Army shall be deemed to have been given to the Land Bank unless and until a copy thereof shall have been so given to the Leasehold Mortgagee. The Leasehold Mortgagee shall then have a period of ten (10) days more after service of notice upon it, for remedying the default or causing it to be remedied, than is given the Land Bank under paragraph 8.01 herein, except in case of imminent danger to safety or health. The Leasehold Mortgagee, in case the Land Bank shall be in default, shall, within the period provided for in this paragraph 9.02 and, if applicable, 9.04, have the right to remedy the default or cause it to be remedied.

9.03 The Army will accept performance by the Leasehold Mortgagee of any covenant, condition, or agreement to be performed under arising out of any pending or contemplated foreclosure action, the following provisions of this paragraph shall apply, namely:

a. The Leasehold Mortgagee must assume the Lease and the Leasehold Mortagee shall have no right with respect to the Lease Premises unless said Leasehold Mortgagee assumes and delivers to the Army a duplicate original of the assumption agreement (to be executed in form for recording) within ten (10) days after said Leasehold Mortgagee acquires title to all or a portion of the Land Bank's interest in the Lease.

b. The Leasehold Mortgagee may transfer its interest in the Lease to a nominee or a wholly-owned subsidiary corporation without the prior consent of the Army, provided, however, that the Leasehold Mortgagee shall deliver to the Army in due form for recording within ten (10) days after the date of the transfer a duplicate original of the instrument of assignment and an instrument of assumption by the transferee of all of the Land Bank's obligations under the Lease, and provided further that the Army shall be given prior written notice of such transfer, and that the transferee shall use the Lease Premises in a manner that conforms to the Reuse Plan. The Leasehold Mortgagee shall be relieved of any further liability under the Lease after the transfer.

9.08 Any purchaser at a foreclosure sale must assume the Lease and said purchaser shall have no right with respect to the Lease Premises unless said purchaser so assumes and delivers to the Army a duplicate original of the assumption agreement (to be executed in form for recording) within ten (10) days after said purchaser acquires title to all or a portion of the Land Bank's interest in the Lease.

12.02 If, on or before the date of expiration of this Lease or its termination by the Land Bank or the Army in accordance with the terms hereof, the Land Bank shall vacate the Lease Premises, the Land Bank will remove any personal property of the Land Bank therefrom, and restore the Lease Premises to as good order and condition as that existing upon the date of commencement of the term of this Lease, except for: (a) alterations, site preparation, improvements or demolition undertaken -- (i) pursuant to this Article 12, Article 16, or otherwise hereunder by the Army in conjunction with environmental remediation or UXO clearance activities, or (ii) with the permission of the Army; or (b) due to fair wear and tear. If this Lease is terminated by the Army in accordance with the terms hereof, the Land Bank shall vacate the Lease Premises, remove personal property therefrom, and restore the Lease Premises to the condition aforesaid within such reasonable time as the Army may designate. In either event, if the Land Bank does not remove said personal property and so restore the Lease Premises, then, at the option of the Army, said personal property shall either become the property of the United States, without compensation therefor, or the Army may cause it to be removed and the Lease Premises to be restored at the expense of the Land Bank, and no claim for damages against the United States or its officers or agents shall be created by or made on account of such removal and/or restoration work.

ARTICLE 13
NOTICES

13.01 All notices to the parties shall be addressed to them at the respective addresses first given for them in this Lease, or to such other address of which either of them, as the case may

ARTICLE 16

ENVIRONMENTAL AND SAFETY PROVISIONS

16.01 The parties acknowledge that Fort Devens has been identified as a National Priorities List Site under CERCLA. The Land Bank acknowledges that the Army has provided it with a copy of the FFA and will provide the Land Bank with a copy of any amendments thereto. The Land Bank agrees to abide by the applicable terms of the FFA and any documents originating therefrom, and further agrees that should any conflict arise between the terms of the FFA, as it may be amended, and the Lease, the FFA shall take precedence. The Land Bank further agrees that, except as provided in the provisions of Article 5 of the MOA, the Army assumes no liability to the Land Bank should implementation of the FFA interfere with the Land Bank's use of the Leased Premises, provided, however, that the Army shall, to the extent reasonable, practical, and without additional costs, minimize interference with such use. The Land Bank shall have no claim on account of any such interference against the Army or any officer, agent, employee or contractor thereof, other than for abatement of rent.

16.02 The United States' rights under this Lease specifically include the right for United States officials to inspect, upon reasonable notice, the Leased Premises for compliance with environmental, safety, and occupational health laws and regulations, whether or not the United States is responsible for enforcing them. Such inspections are without prejudice to the right of duly constituted enforcement officials to make such inspections. The United States normally will give the Lessee twenty-four (24) hours prior notice of its intention to enter the Leased Premises unless the United States determines earlier entry is required for safety, environmental, operations, or security purposes. The Lessee shall have no claim on account of any entries against the United States, the Commonwealth, or any officer, agent, employee, or contractor thereof.

d. to construct, operate, maintain or undertake any other response or remedial action as required or necessary under the FFA, including, but not limited to, monitoring wells, soil removal, pumping wells and treatment facilities;

provided that the Leased Premises are restored in a reasonable manner to their condition prior to the exercise of the above rights, and provided further that any such inspection, survey, investigation or other response or remedial action will, to the extent reasonable, practical and without significant additional cost, be coordinated with a representative of the Land Bank and be performed in a manner that will minimize interference with the operations of the Land Bank. The Land Bank agrees to comply with the provisions of any health or safety plan in effect during the course of the above-described response or remedial actions.

16.05 The Land Bank or any agent or contractor of the Land Bank shall not undertake subsurface excavation, drilling, digging or other substantial disturbance of the surface of the ground, or construction, alterations, additions, modifications, improvements or installations that may adversely affect the clean up being undertaken on the Leased Premises or other portions of the Fort Devens NPL site, without: (a) seven (7) days prior written notice to the Army, EPA and DEP; and (b) prior written consent of the Army, which consent shall not be unreasonably withheld or delayed, and which consent may include a requirement for written approval by the EPA and DEP. Such consent may involve a requirement to provide the Army with a performance and payment bond satisfactory to it in all respects and other requirements deemed necessary to protect the interests of the Army. No groundwater will be extracted for any purpose. Excavation of garbage or landfill materials is prohibited.

16.06 The Land Bank hereunder shall be solely responsible for obtaining, at its cost and expense, any environmental permits required for its operations under the Lease, independent of any

The parties hereto acknowledge and agree that the Leased Premises consist of parcels identified by the Army and EPA as parcels that require further environmental remediation, or documentation of the completion of remediation, by the Army, and include areas designated as Areas of Contamination, Study Areas, and Areas Requiring Environmental Evaluation.

16.11 Notices

a. Preceding expiration, revocation or termination of this lease, the Lessee shall fully fund the Army's preparation of an updated EBS that will document the environmental condition of the property at that time in conjunction with the close-out survey and report, as described in Article 3.02 of this Lease. The updated EBS will serve to support the FOST for the transfer or conveyance of the property or, if the termination is not for purposes of conveying said property, a comparison of the initial and close-out surveys will assist the Division Engineer in determining any environmental restoration requirements, to be completed by the Lessee in accordance with the condition Article 12 of this Lease.

b. NOTICE OF HAZARDOUS SUBSTANCES. To the extent such information is available on the basis of a complete search of Army files, notice regarding hazardous substances stored for one year or more, known to have been released, or disposed of on the Leased Premises is provided in the notice attached to the MOA (Exhibit B herein). The Land Bank should consult the EBS for more detailed information.

c. NOTICE OF THE PRESENCE OF ASBESTOS. The Leased Premises are known to contain certain amounts of asbestos, such as in, but not limited to, the floor tile, linoleum and associated mastic, asbestos-containing pipe and tank insulation, heating, ventilating and air conditioning vibration joint cloths, exhaust flues, acoustic ceiling treatment, siding, and roofing materials.

which have been provided to the Lessee. All lessees and sublessees must also receive the federally approved pamphlet on lead poisoning prevention. The Lessee hereby acknowledges receipt of the information described in this paragraph.

(2) The Lessee and its sublessees, successors, and assigns, shall not permit the occupancy of any target housing without complying with this section 16.07d and all applicable federal, state, and local laws and regulations pertaining to lead-based paint and/or lead-based paint hazards. Prior to permitting the occupancy of target housing, if required by law or regulation, the Lessee will abate and eliminate lead-based paint hazards by treating any defective lead-based paint surface in accordance with all applicable laws and regulations.

e. NOTICE OF THE PRESENCE OF RADON. Buildings on the Lease Premises may contain unhealthy levels of radon. Available and relevant radon assessment data pertaining to the Lease Premises are in the EBS. Prior to the use of any building for residential use or 24-hour per day occupancy, the Lessee, at its expense, must take appropriate measures to reduce the radon level to safe levels, in accordance with EPA guidelines.

f. NOTICE OF THE PRESENCE OF UXO. Certain portions of the Lease Premises, as designated as A2, A21, and A22 in Exhibit A herein (UXO Parcels), are subject to further UXO clearance by the Army, which clearance shall be undertaken by the Army promptly and at Army expense, subject to availability of funds. The Army will inform the Land Bank in writing when the clearance has been completed.

16.12 Each sublease, tenancy or license agreement made by the Land Bank hereunder shall contain provisions that will ensure the continuing compliance of the Land Bank, and the grantee

ARTICLE 17
DISPUTES CLAUSE

17.01 Except as provided in the Contract Disputes Act of 1978 (41 U.S.C. 601-613) (the Act), all disputes arising under or relating to this lease shall be resolved under this clause and the provisions of the Act.

17.02 "Claim", as used in this clause, means a written demand or written assertion by the Land Bank seeking, as a matter of right, the payment of money in a sum certain, the adjustment of interpretation of lease terms, or other relief arising under or relating to this lease. A claim arising under this lease, unlike a claim relating to this lease, is a claim that can be resolved under a lease clause that provides for the relief sought by the Land Bank. However, a written demand or written assertion by the Land Bank seeking the payment of money exceeding $100,000 is not a claim under the Act until certified as required by section 17.04 below.

17.03 A claim by the Land Bank shall be made in writing and submitted to the Division Engineer for a written decision. A claim by the United States against the Land Bank shall be subject to a written decision by the Division Engineer.

17.04 For Land Bank claims exceeding $100,000, the Land Bank shall submit with the claim a certification that (i) the claim is made in good faith; and (ii) supporting data are accurate and complete to the best of the Land Bank's knowledge and belief; (iii) and the amount requested accurately reflects the lease adjustment for which the Land Bank believes the United States is liable.

then at the rate applicable for each 6-month period as fixed by the Treasury Secretary during the pendency of the claim.

17.10 The Land Bank shall proceed diligently with the performance of the lease, pending final resolution of any request for relief, claim, or action arising under the lease, and comply with any decision of the Division Engineer.

ARTICLE 18
MISCELLANEOUS

18.01 Both parties acknowledge and agree that a Notice of Lease will be recorded in the public records, which Notice shall be signed by the parties hereto and identify the Lease Premises.

18.02 The Lease is subject to all existing easements and rights of way of record.

18.03 The provisions of this Lease are not subject to 10 U.S.C. §2662.

18.04 This Lease contains the entire agreement between the parties regarding the lease of the Lease Premises to the Land Bank, and any agreement hereafter made shall not operate to change, modify or discharge this Lease in whole or in part unless that agreement is in writing and signed by the party sought to be charged with it.

18.05 No member or delegate to Congress or Resident Commissioner shall be admitted to any share or part of this Lease or to any benefit to arise therefrom. Nothing herein contained, however, of this Lease shall remain enforceable to the fullest extent permitted by law.

18.12 Discrimination.

a. The Lessee shall not discriminate against any person or persons or exclude them from participation in the Lessee's operations, programs or activities conducted on the Leased Premises, because of race, color, religion, sex, age, handicap, or national origin.

b. The Lessee, by acceptance of this lease, is receiving a type of Federal assistance and, therefore, hereby gives assurance that it will comply with the provisions of Title VI of the Civil Rights Act of 1964, as amended (42 U.S.C. § 2000d); the Age Discrimination Act of 1975 (42 U.S.C. § 6102); and the Rehabilitation Act of 1973, as amended (29 U.S.C. § 794). This assurance shall be binding on the Lessee, its agents, successors, transferees, sub-lessees and assignees.

Article 19
Insurance

19.01. At the commencement of this lease, the Land Bank shall obtain, from a reputable insurance company, or companies, comprehensive liability insurance. The insurance shall provide an amount not less than a combined single limit of $1,000,000 for any number of persons or claims arising from any one incident with respect to bodily injuries or death resulting therefrom, property damage, or both, suffered or alleged to have been suffered by any person or persons resulting from the operations of the Lessee under the terms of this lease.

part thereof should it be diminished in value, damaged or destroyed. The purchase price will not be altered should such damage occur and the Lessee has failed to obtain insurance. Any proceeds paid to the United States shall be applied to the purchase price.

19.04 The Land Bank shall maintain worker compensation and employer's liability insurance as required by the Commonwealth of Massachusetts.

IN WITNESS WHEREOF, the parties have executed the Lease as of the day and year first above written.

UNITED STATES OF AMERICA

By Paul W. Johnson
Paul W. Johnson
Deputy Assistant Secretary of the Army
(Installations and Housing)

THE GOVERNMENT LAND BANK

By: Michael P. Hogan
Michael P. Hogan
Executive Director