Groundwater Plume Maps & Information Booklet

Air Force Center for Engineering and the Environment
Massachusetts Military Reservation
Cape Cod, Massachusetts

2010

Understanding Contamination and Paths to Exposure

RISK

Risk is a measurement of the likelihood that people, plants, or animals may experience negative effects as a result of their exposure to contamination. Risk factors are considered to be the type of contaminant, its concentration, and the duration and nature of contact or exposure.

The Air Force Center for Engineering and the Environment (AFCEE) Installation Restoration Program (IRP) is one of several organizations that address ongoing concerns of risk and public health for those who reside near the Massachusetts Military Reservation (MMR) in the surrounding towns of Bourne, Falmouth, Mashpee, and Sandwich.

AFCEE is currently involved with 80 locations on the MMR that have been investigated and 11 groundwater plumes are undergoing treatment. One plume and additional areas are being monitored. AFCEE has taken appropriate measures to clean up and restore contaminated soil and groundwater.

AFCEE, the U.S. Environmental Protection Agency (EPA), and the Massachusetts Department of Environmental Protection (MassDEP) have and continue to make efforts to eliminate exposure pathways that could put people at risk from base-related contamination. In areas potentially affected by groundwater contamination, residences have been connected to municipal water supplies. AFCEE initiated a program in 2008 to validate the status and safety of existing private wells in plume areas since some of these wells could still be used for a potable water source and/or for outside watering purposes. Wells that continue to be used in areas near plumes are tested free of charge to homeowners. Water in nearby recreational ponds (Ashumet, Johns, Coonamessett, Deep, Jenkins, Round, and Snake Ponds) is tested twice during the recreational season, with results to date showing no base-related contaminants. Potential impacts on ecosystems in ponds, vernal pools, wetlands, rivers, and salt water harbors are also monitored. Other actions to eliminate exposure pathways are addressing source areas and constructing treatment systems to clean up the plumes. These systems are monitored to ensure that no unsafe levels of contaminants are reintroduced back into the environment when treated water is returned to the aquifer, or when soil is cleaned.

If there is no exposure, there is no health risk.

Exposure can only occur if there is a pathway for the contaminant to travel from the source to people, plants, or animals. Exposure pathways include:

1. Ingestion (drinking or eating contaminated water or food)
2. Dermal contact (touching contaminated soil or water: e.g., showering, swimming)
3. Inhalation (breathing in contaminated vapors of chemicals that evaporate into air)

Different routes of exposure to a contaminant can result in different health concerns. The following factors and characteristics determine the type and severity of health effects that may occur as a result of exposure to contaminants:

- Concentration (how much)
- Carcinogenic or noncarcinogenic contaminant
- Frequency (number of days per year)
- Age (child or adult receptor)
- Duration (number of years)
- Specific sensitive groups (e.g., pregnant women)
- Toxicity (characteristics of the chemical)

In order for there to be a risk, there must first be an exposure to a contaminant. The amount of risk to one's health depends on the duration of exposure, the toxicity of the particular contaminant, the concentration of the contaminant, and various personal factors. The primary potential health risk at and around MMR is from drinking contaminated groundwater. No exposure means no risk.

Source areas are located on base and most have already been cleaned up. The majority of residences around the base are connected to municipal water. For those residences not connected to municipal water and located in an area that might be potentially at risk, AFCEE conducts a voluntary residential well sampling program. Most of the residential wells in the area draw water from a shallow depth or zone in the upper portion of the aquifer while most of the plumes associated with MMR are deep — as much as 100 to 200 feet below the ground surface. If there is no possibility of exposure to contaminants, and there is no reason to believe that there will be in the future, the contaminants do not pose a risk to human health or the environment. Since AFCEE began managing the IRP at MMR, there have been no known detections of plume-related contaminants in residential private wells above safe drinking water limits.

AFCEE has provided more than 1,100 conversions from private well systems to municipal water in the four Upper Cape towns in the plume areas, but many residential and irrigation wells were not closed at the time of those conversions. As part of AFCEE's Land Use Control Program, if homeowners are interested in keeping and using their wells, a risk assessment will be completed. This would involve an evaluation of the depth of the well in proximity to the plume and may include testing of the well water. AFCEE will offer free decommissioning of any well that is found to present an unacceptable risk (this involves disconnecting piping to the house and filling in the well casing). If decommissioning is not accepted, AFCEE will take other steps to insure protectiveness, such as requesting assistance from the appropriate Board of Health to prevent exposure, offering bottled water (if the well is used for drinking), installing a treatment system on the well, or providing a municipal water supply connection.

Since AFCEE began managing the IRP at MMR, there have been no known detections of plume-related contaminants in residential private wells above safe drinking water limits.

Some terms you need to know.

COC = Contaminant of Concern

gpm = Gallons Per Minute

GW-1 = State default cleanup value to be used in lieu of site-specific risk-based level

MCL = Maximum Contaminant Level
A maximum contaminant level is the highest level of a contaminant that is allowed in drinking water. MCLs are enforceable standards by the EPA.

MMCL = Massachusetts Maximum Contaminant Level
In cases where the MMCL is lower than EPA's MCL, the more stringent (lower) standard is applied as part of AFCEE's analysis and cleanup actions.

MG = Million Gallons

ROD = Record of Decision

SPEIM = System Performance and Ecological Impact Monitoring

µg/L = Micrograms Per Liter
A microgram per liter is approximately 1 drop in 22,000 gallons

The most toxic COCs are those with the lowest target cleanup levels. For example, a half-drop of EDB would conceptually bring an Olympic size swimming pool's concentration equal to the EDB MMCL of 0.02 µg/L. Similarly, it would take 1 ¾ teaspoons of TCE to bring an Olympic size swimming pool's concentration equal to the TCE MCL of 5 µg/L.

At MMR there are a number of COCs		
Contaminant of Concern	***Cleanup Level***	***Type of Contaminant***
trichloroethene (TCE)	5 µg/L	solvent
perchloroethene (PCE)	5 µg/L	solvent
carbon tetrachloride (CCl_4)	5 µg/L	solvent
ethylene dibromide (EDB)	0.02 µg/L	fuel-related compound
benzene	5 µg/L	fuel-related compound
vinyl chloride (breakdown product of reductive chlorination)	2 µg/L	solvent
1,1,2,2-TeCA	2 µg/L	solvent
1,4-dichlorobenzene	5 µg/L	solvent
manganese	300 µg/L	metal
thallium	2 µg/L	metal
lead	15 µg/L	metal
toluene	1,000 µg/L	fuel
RDX	0.6 µg/L	explosive

Source Areas

A source area is an area considered to be a possible "source" of contamination to the environment. These areas contain contaminated soil as a result of past spills or other activities and, depending on the type and concentration of contamination, could threaten the underlying groundwater or the plants, animals, or humans who come into direct contact with the contaminated soil.

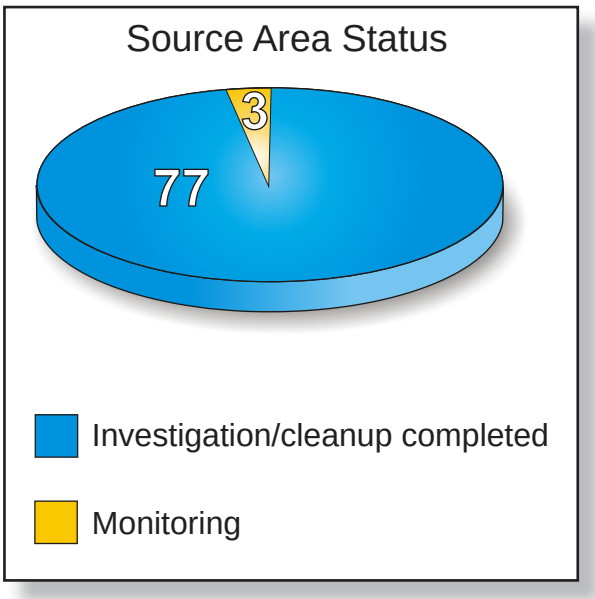
There are 80 locations on the MMR that have been evaluated as part of the Air Force cleanup efforts. Many of those locations were confirmed as source areas that contributed to soil and/or groundwater contamination at some point in the past. The current status of the source areas is shown in the graphic below. Contaminated soil is either treated in place or excavated and transported to an approved facility for on-base or off-base treatment and/or disposal. For contamination that is too deep to safely excavate, in-place soil cleanup is conducted. This involves a treatment called soil vapor extraction (SVE). In the SVE process, pipelines are used to apply a vacuum to the soil and remove the contaminants as vapor, which is then treated with carbon in a vapor treatment system.

In several cases, source areas have contributed to groundwater contamination at concentrations exceeding MCLs or MMCLs, thereby creating a groundwater plume.

In the summer of 2007, EPA published in the Federal Register a Notice of Intent (NOI) for Partial Deletion from the Otis Air National Guard Base/Camp Edwards Superfund Site (MMR). The NOI covered 61 source areas on the MMR. All of these sites have been investigated and, where needed, cleanup actions were completed. Determinations of no-further-response and no-further-risk to human health and the environment have been made for these sites. The sites that are associated with groundwater plumes have not been included, even though investigation and/or cleanup may have been completed.

Although some sites are located within plume boundaries from the two-dimensional perspective, site investigation data and plume data demonstrate that these sites are not connected to plumes. Therefore, EPA believes that it is acceptable to partially delist a surface site while a groundwater plume is undergoing cleanup. The partial deletion does not include groundwater plumes where cleanup levels have not been met or sites where investigation or cleanup is ongoing.

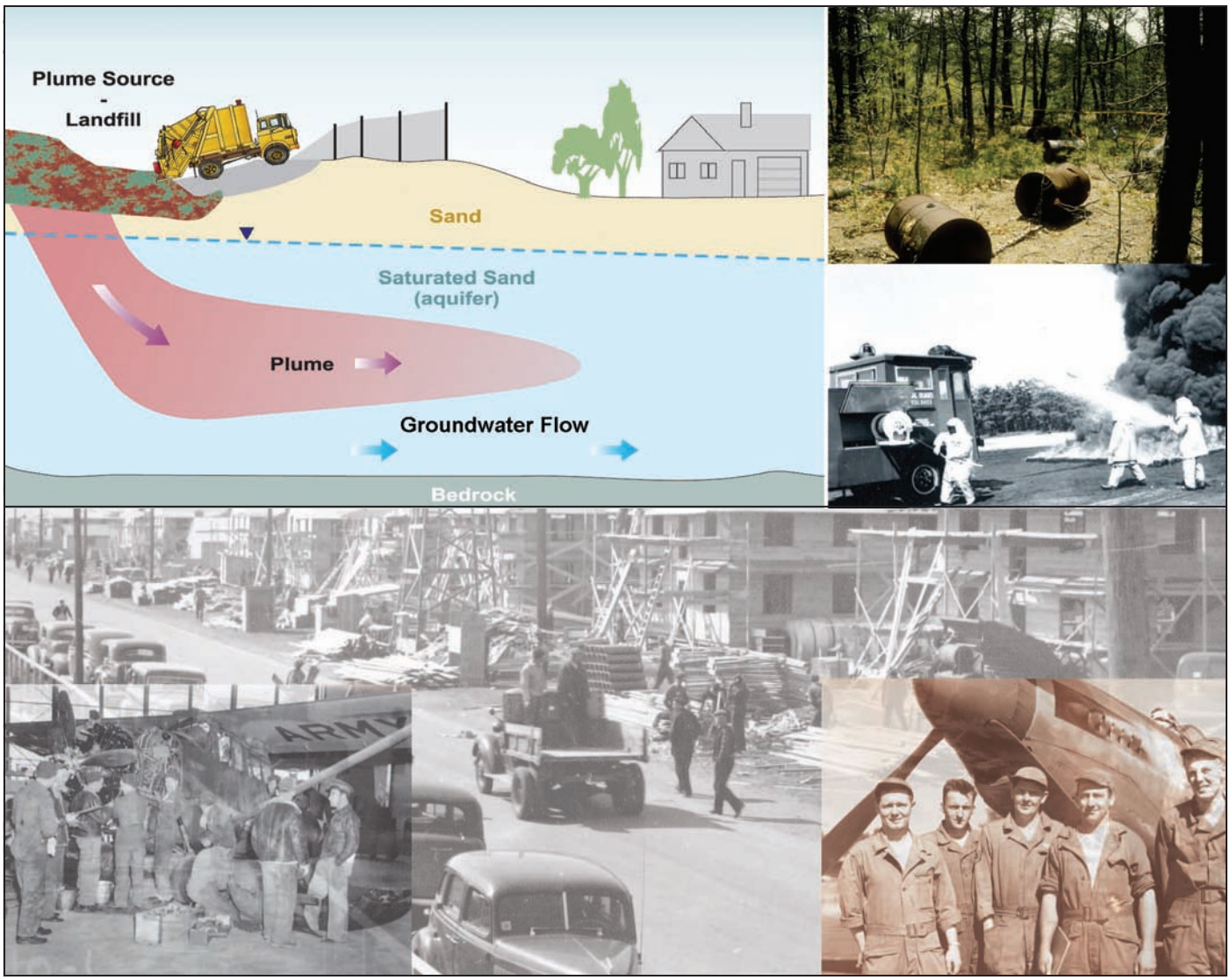
In late 2007, this partial deletion was finalized. If any new contamination information becomes available, EPA may reopen any site that was previously deleted.



Where did this contamination come from?

Since the early 1900s, MMR has been used for military purposes, including troop training and maneuvers, military aircraft operations, vehicle maintenance, and support. Some activities required the use of petroleum products, solvents, and other hazardous materials. It was common practice for many years at the MMR, as it was at other military bases and industrial facilities throughout the country, to dispose of wastes in unlined landfills and drywells, to dump and burn them at firefighter-training areas, or to rinse them down drains. In addition, pipeline breaks and accidental spills occurred at MMR. Today, the use and disposal of hazardous materials is strictly managed and regulated at MMR to be protective of the environment. The IRP is the program that cleans up soil and groundwater contamination resulting from historic use of the southern portion of MMR. AFCEE is the agency that is responsible for the IRP. EPA and MassDEP oversee AFCEE's cleanup effort at MMR.

The U.S. Army Environmental Command's Impact Area Groundwater Study Program (IAGWSP) is responsible for addressing soil and groundwater contamination from historic activities at Camp Edwards on the northern portion of MMR. The phone number for the IAGWSP office is (508) 968-5630.



How are the groundwater plumes treated?

A plume is a body of groundwater containing contaminants that exceed federal and/or state safe drinking water standards. When chemicals from source areas travel downward through the sandy soils, they eventually reach the aquifer where they begin to dissolve. Once dissolved, they begin to move with the groundwater, thus creating a plume.

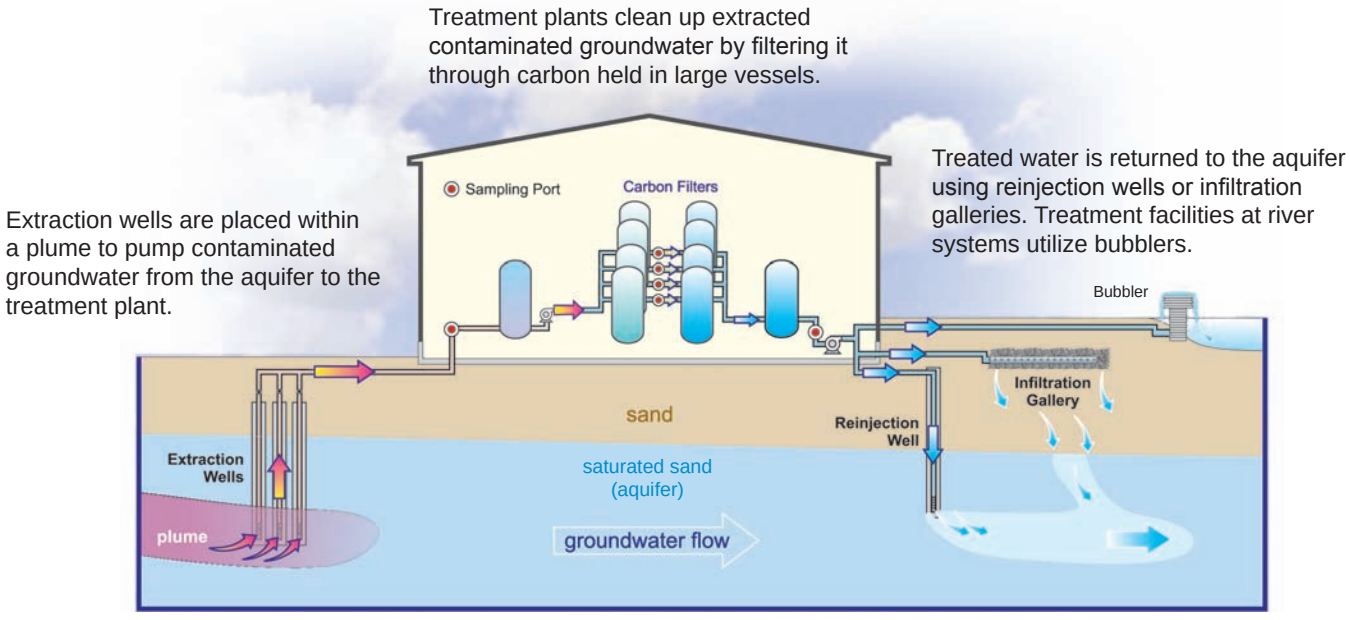
To actively treat groundwater contamination, extraction wells are placed within a plume to pump the contaminated groundwater from the aquifer to a treatment plant where the water is filtered through carbon held in large vessels. (The used carbon is recycled off site and reused at MMR.) Treated water is returned to the aquifer using reinjection wells or infiltration galleries, while treatment facilities at river systems utilize bubblers.

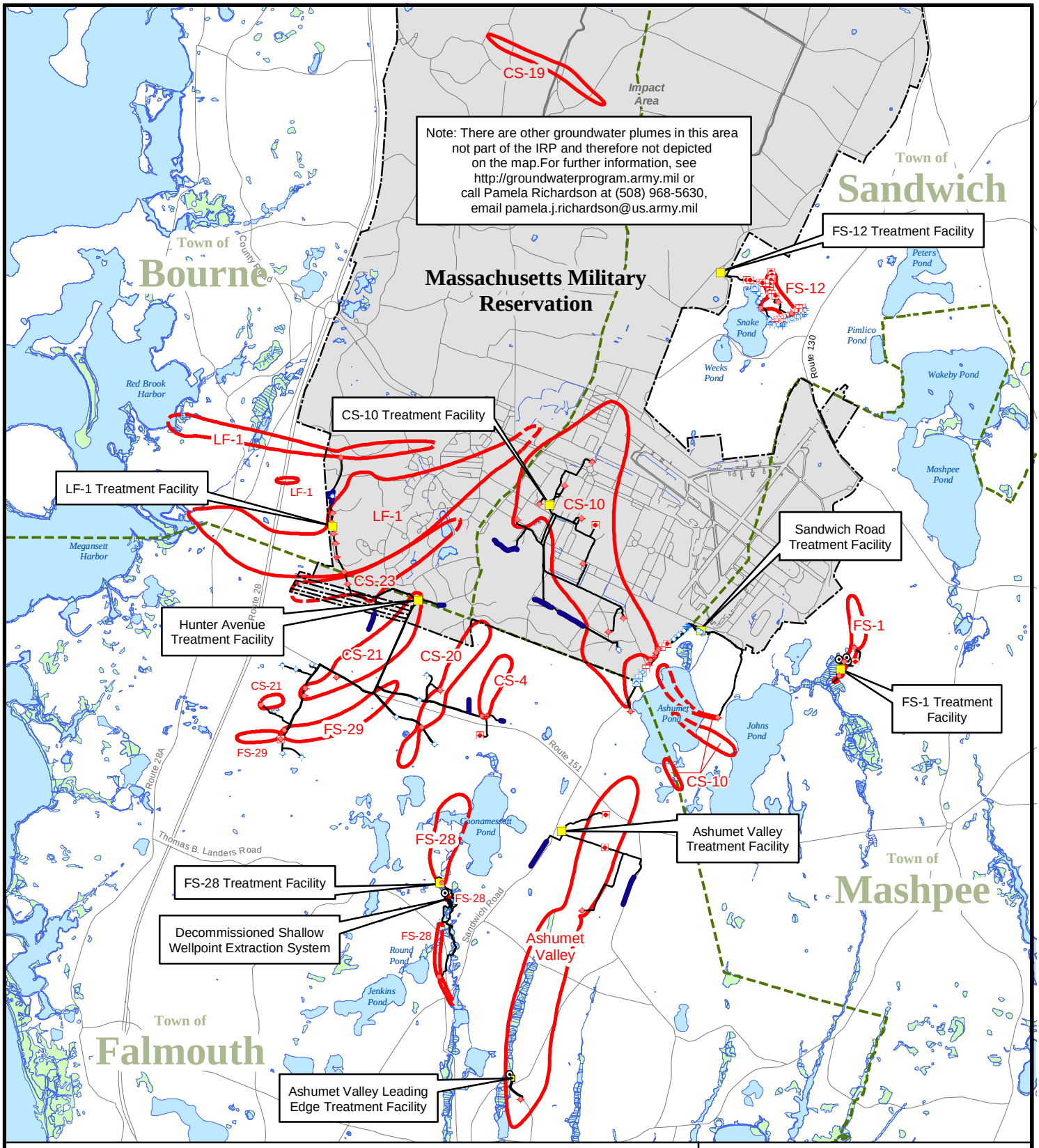
The IRP is currently addressing 12 groundwater plumes. Many of these plumes are located beyond the MMR boundary and are currently in various stages of study and cleanup. At this time, systems are treating approximately 14 million gallons of groundwater per day. Computer modeling suggests that it may take more than 30 years to fully remediate all of the groundwater contamination associated with MMR. Several plumes have shown dramatic decreases in size and contaminant concentrations due to years of groundwater treatment actions. Plumes and treatment systems are continually being monitored and optimized to reduce the overall cleanup time.

Eleven plumes are undergoing groundwater cleanup: Ashumet Valley, Chemical Spill 4 (CS-4), CS-10, CS-20, CS-21, CS-23, Fuel Spill 1 (FS-1), FS-12, FS-28, FS-29, and Landfill 1 (LF-1).

One plume, CS-19, is in long-term monitoring. LF-2 and Storm Drain 5 (SD-5), two sites where the groundwater contamination no longer meets the definition of a plume, are also in long-term monitoring.

The Groundwater Treatment Process





Data Source: AFCEE, March 2010, AFCEE-MMR Data Warehouse

Legend

- Plume Boundary (Dashed Where Inferred) Defines Area of Groundwater Contaminants of Concern Above Regulatory Limits
- Reinjection Well
- Extraction Well
- Reinjection Well (Off)
- Extraction Well (Off)
- Outflow Bubbler
- Treatment Facility
- Treatment System Piping
- Infiltration Gallery/Trench
- Town Boundary
- Bog/Wetland

N

0 0.6 1.2 Miles

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IRP PLUMES AND TREATMENT SYSTEMS APRIL 2010

Installation Restoration Program
AFCEE - Massachusetts Military Reservation

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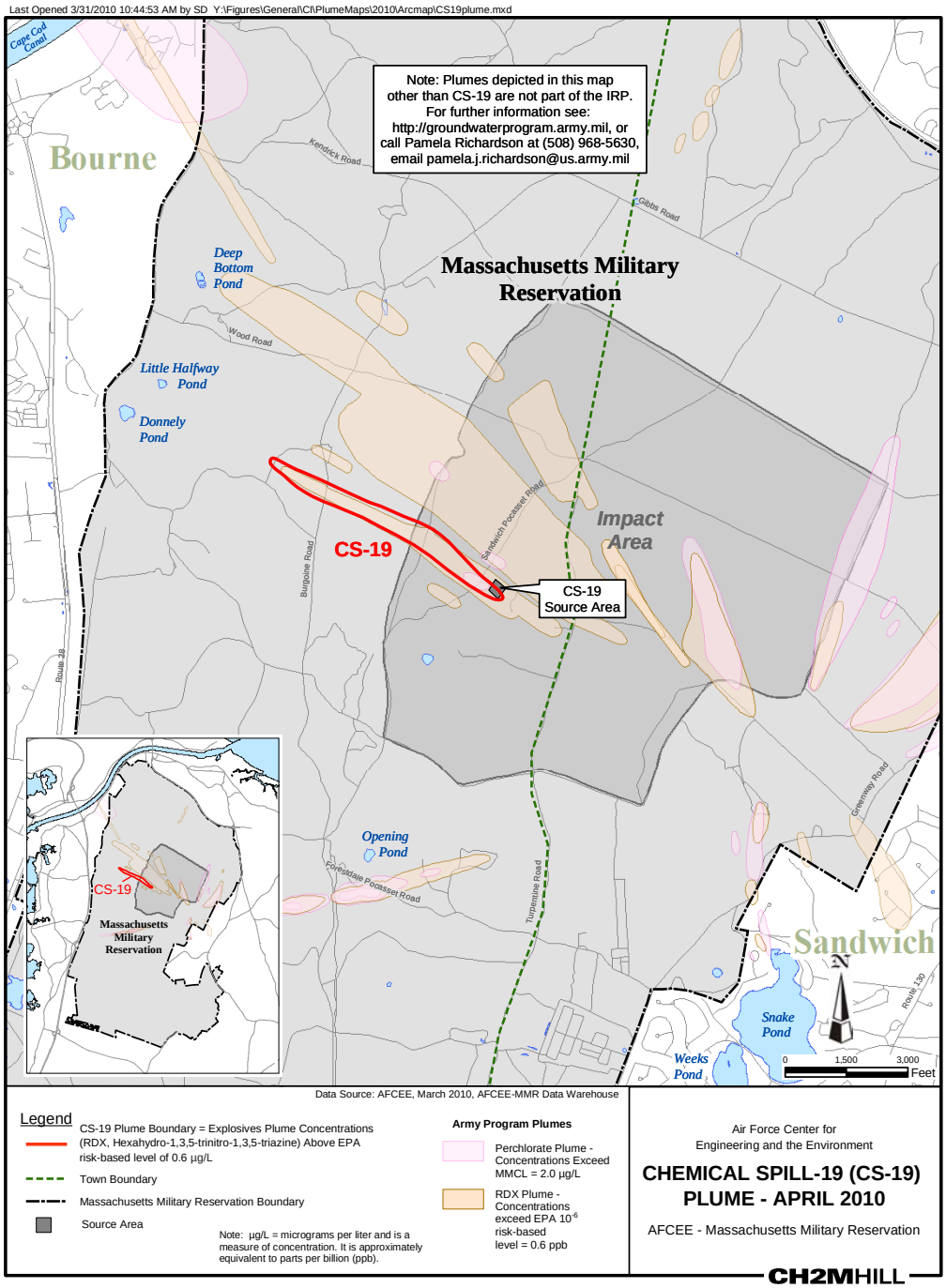
CS-19 Groundwater Plume

The CS-19 site involves past ordnance and military waste disposal. An area of approximately two acres was used to bury and detonate ordnance and munitions debris at depths to 12 feet. These ordnance and waste disposal practices at the CS-19 site resulted in contaminants being released to the surrounding soil and groundwater. AFCEE conducted multiple testing and cleanup actions at CS-19 between 2004 and 2009, including the removal of more than 2,800 cubic yards of soil, 8,500 ordnance items, and 27,000 pounds of munitions debris from the original two-acre site.

RDX, an explosives compound, is the contaminant of concern associated with CS-19. The groundwater plume is defined by RDX concentrations above the EPA risk-based level of 0.6 µg/L.

The CS-19 plume is located within the Central Impact Area (CIA) study area and adjacent to the CIA groundwater plume, which is managed by the IAGWSP. For more information about the IAGWSP, please call 508-968-5630 or visit the website at http://groundwaterprogram.army.mil.

A 2009 ROD calls for continued monitoring of groundwater concentrations and implementation of land use controls to prevent residential exposure. The plume is not anticipated to move beyond the base boundary. The final remedy selected for the CS-19 groundwater plume will not predetermine or limit remedial options for the CIA plume, which is in close proximity to CS-19.



CS-10 Groundwater Plume

The Chemical Spill 10 (CS-10) groundwater plume resulted from spills and releases from multiple sources. The primary source area originated from the former Boeing Michigan Aerospace Research Center Missile Site (from 1960 to 1973) and Unit Training Equipment Site (UTES). From 1996 through 2005, several source area cleanup actions were conducted at the site, including 15 drainage structure removals, and soil treatment with soil vapor extraction. More than 1,500 tons of contaminated soil were excavated and taken off site for disposal.

Groundwater concentrations in monitoring wells located in the source area no longer exceed cleanup levels and the plume is detached from its primary source area. Studies have shown that portions of the CS-10 plume no longer discharge to Ashumet and Johns Ponds. Surface water sampling from both ponds in 2009 showed zero detections of contaminants associated with CS-10.

The primary contaminants in the CS-10 plume are the cleaning solvents PCE and TCE, which have been detected above the state and federal MCLs of 5 µg/L. Long-term remediation is occurring with a treatment system comprised of a series of extraction wells, treatment plants, reinjection wells, and infiltration galleries. The treatment plants use granular activated carbon to remove the solvents from the groundwater and the treated water is returned to the aquifer through the infiltration galleries and reinjection wells.

An additional extraction well to address the southern trench contamination, an additional reinjection well to improve hydraulic capture of the plume, and revised flow rates in several extraction wells were completed in February 2009.

The CS-10 Plume final ROD, signed in 2009, specified continued operation and monitoring of the existing treatment system along with land use controls.

CS-10					
Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
August 2009	June 1999	2055	PCE	51	400 (July 2000)
			TCE	1740	5110 (June 1997)

Treatment Components in Operation[1]		# Treatment Plants		Treatment Rate (gpm) (original/current)[1]	Volume Treated (MG)[2]
Extraction Wells	15	In Plume	2	2780/2290	13565
Reinjection Wells	12	Sandwich Road	1	820/410	4204
Infiltration Trenches	2	Northern Lobe uses SR		75/190	979.9

CS-10 Plume Treatment Systems, SR = Sandwich Road
ROD = Record of Decision, DD = Decision Document, µg/L = micrograms per liter, MG = million gallons, gpm = gallons per minute,
1. Current treatment rate as of April 1, 2010, 2. Through December 2009

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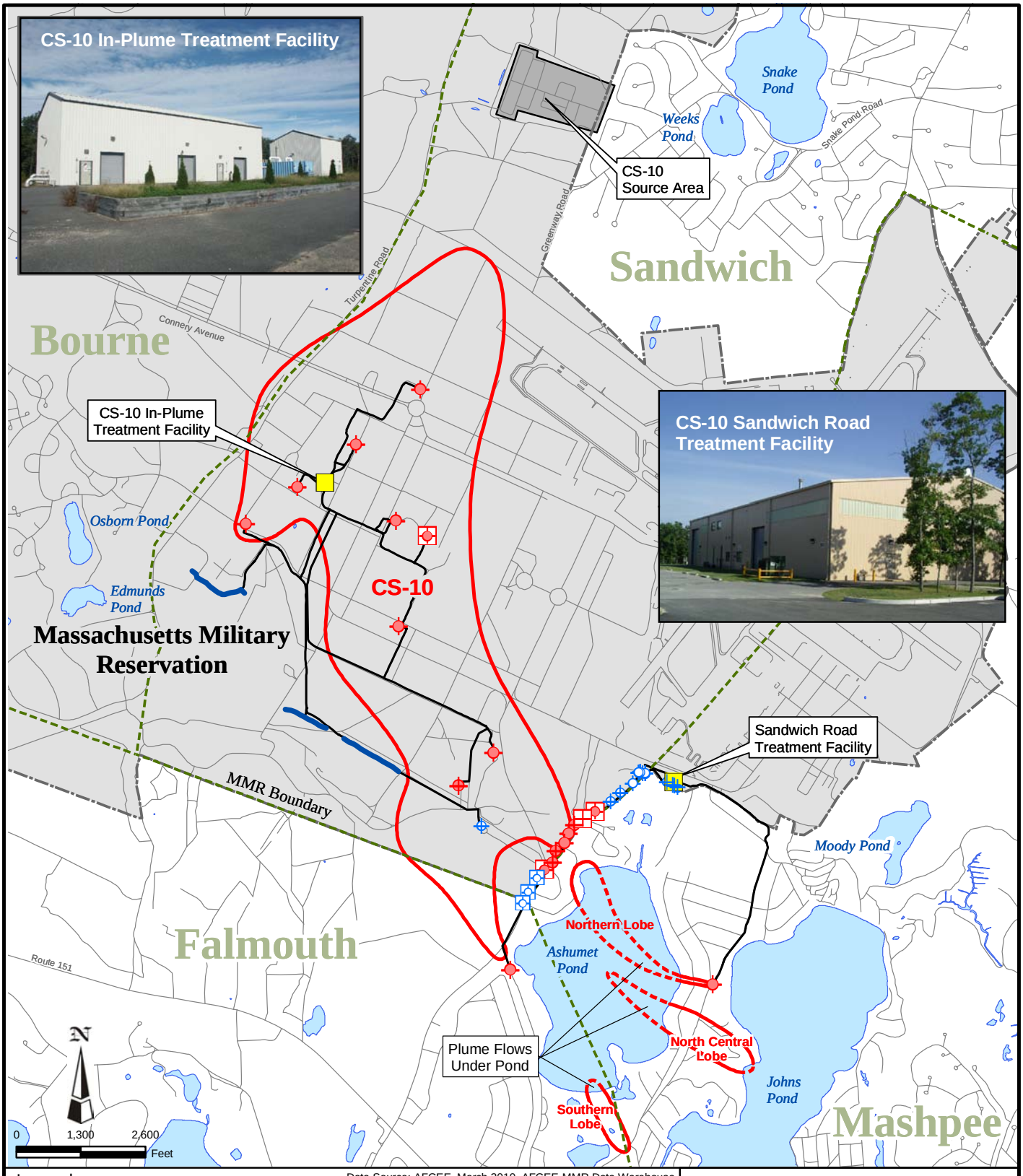

Legend

Data Source: AFCEE, March 2010, AFCEE-MMR Data Warehouse

- CS-10 Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL), dashed where inferred. Represents an exceedance of trichloroethene (TCE) and/or perchloroethene (PCE). (TCE MCL = 5 µg/L) (PCE MCL = 5 µg/L)
- Massachusetts Military Reservation Boundary
- Town Boundary
- Infiltration Trench
- Treatment System Piping
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)
- Treatment Facility
- Source Area

Air Force Center for Engineering and the Environment

CHEMICAL SPILL-10 (CS-10) PLUME - APRIL 2010

AFCEE - Massachusetts Military Reservation

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Ashumet Valley Groundwater Plume

The Ashumet Valley plume has two sources: the former firefighter-training area 1 (FTA-1) and the former MMR Sewage Treatment Plant (CS-16 and CS-17). Firefighter-training exercises were held from 1958 to 1985 at FTA-1, during which time flammable waste liquids were burned and extinguished, some of which entered the sandy soil and eventually reached the groundwater aquifer. The former sewage treatment plant, which operated from 1936 to 1995, released treated water to a series of sand infiltration beds. Sludge materials were kept on site.

Treatment of contaminated soils at FTA-1 was completed in September 1997. A total of 42,531 tons of soil were treated at FTA-1 using a thermal treatment process. In 2001 and 2002, contaminated soil was removed from the CS-16 and CS-17 sites and taken off base for proper disposal.

The primary contaminants in the Ashumet Valley plume are the cleaning solvents PCE and TCE, which have been detected above the state and federal MCLs of 5 µg/L. The Ashumet Valley plume is currently in long-term remediation. Remediation is occurring with two treatment systems, each comprised of a single extraction well, treatment plant, and infiltration galleries/ river discharge. The treatment plants use granular activated carbon to remove the solvents from the groundwater and the treated water is returned to the aquifer through the infiltration galleries in the central portion of the plume, and to a bog ditch along the Backus River in the southern area.

The Ashumet Valley Plume final ROD, which was signed in 2009, specified continued operation of the existing treatment system plus additional treatment for the southern portion of the plume. The southern treatment system has been installed. The ROD also required land use controls.

AFCEE does not believe that any portion of the plume is currently discharging into Ashumet Pond. Surface water sampling from Ashumet Pond in 2009 showed that no plume contaminants were detected.

In 2001, AFCEE applied an alum treatment to Ashumet Pond water to reduce the amount of phosphorus in the pond, much of which comes from the base's wastewater treatment plant phosphorus plume. In 2004, a geochemical barrier (made up of zero-valent iron mixed with pond sediment) was installed along the shoreline of Ashumet Pond to reduce the amount of phosphorus in groundwater entering the pond. A second alum treatment is being evaluated for 2010.

A part of the southern portion of the Ashumet Valley plume discharges to the Backus River in Falmouth. Surface water testing conducted in 2009 showed results below the MCL. Please note that safe drinking water guidelines (MCLs) do not apply to surface water bodies. AFCEE continues to monitor the entire plume area.

Ashumet Valley					
Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
March 2009	November 1999	2018	PCE	43	109 (October 1998)
			TCE	12	83 (August 1997)

Treatment Components in Operation[1]	# Treatment Plants	Treatment Rate (gpm) (original/current)[1]	Volume Treated (MG)[2]
Extraction Wells 2 Infiltration Trenches 2 Bubbler 1	1	1200/350	4768
	1 Mobile Treatment Unit	175/175	26.8

ROD = Record of Decision, DD = Decision Document, µg/L = micrograms per liter, MG = million gallons, gpm = gallons per minute,
1. Current treatment rate as of April 1, 2010, 2. Through December 2009

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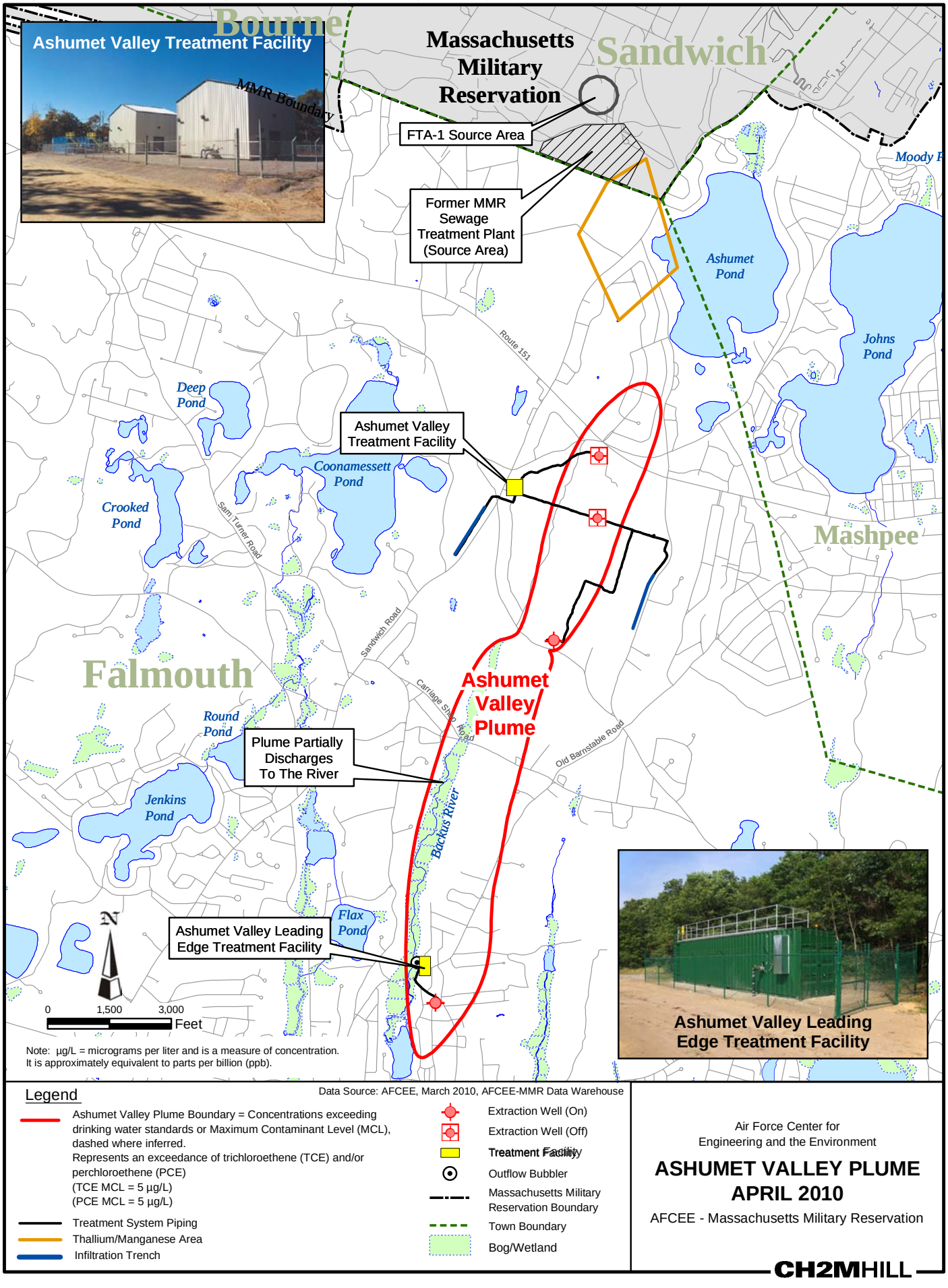

CS-23 and LF-1 Groundwater Plumes

The source of the Landfill 1 (LF-1) groundwater plume was the main MMR landfill, which operated from 1941 to 1990. The LF-1 plume contains many COCs. The more typical COCs are the solvents PCE, TCE, and CCl_4. The state and federal MCLs for PCE, TCE, and CCl_4 is 5 µg/L.

Test data indicate that no significant contamination is being released to groundwater from the older landfill cells at LF-1, and decreasing chemical concentrations in groundwater downgradient of the more recently used landfill cells suggest that the landfill cap there has been effective in reducing groundwater contamination at the source. The cap is inspected annually to monitor its integrity.

The LF-1 ROD, signed in 2007, consists of continued long-term remediation with a groundwater extraction-and-treatment system, and the implementation of land use controls. The contaminated groundwater is treated at the LF-1 Treatment Plant and the Hunter Avenue Treatment Facility. Water is returned to the aquifer through a reinjection well and infiltration trenches.

Because a portion of the LF-1 plume discharges to both Red Brook and Squeteague Harbors, surface water and discharging groundwater at the harbors are tested annually, and results show that there are no ecological or human health risks.

The CS-23 plume is a detached plume that has not been linked to a specific source area. All of the potential source areas for the CS-23 plume have been investigated and/or remediated. The COCs in the CS-23 plume are TCE and CCl_4.

The CS-23 ROD, signed in 2007, consists of continued remediation and operation of the existing groundwater cleanup system and land use controls. The contaminated water is treated at the Hunter Avenue Treatment Facility. Water is returned to the aquifer through infiltration trenches.

LF-1					
Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
October 2007	August 1999	2047	TCE, PCE	37 (TCE)	150 (TCE, Aug 1999)

Treatment Components in Operation[1]	# Treatment Plants	Treatment Rate (gpm) (original/current)[1]	Volume Treated (MG)[2]
Extraction Wells 6 Reinjection Wells 1 Infiltration Trench 2	2	700/1245	3713

CS-23					
Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
October 2007	December 2006	2018	TCE	17.7	57.2 (June 2002)

Treatment Components in Operation[1]	# Treatment Plants	Treatment Rate (gpm) (original/current)[1]	Volume Treated (MG)[2]
Extraction Wells 2 Infiltration Trench 2	1	700/700	991

ROD = Record of Decision, DD = Decision Document, µg/L = micrograms per liter, MG = million gallons, gpm = gallons per minute,
1. Current treatment rate as of April 1, 2010, 2. Through December 2009

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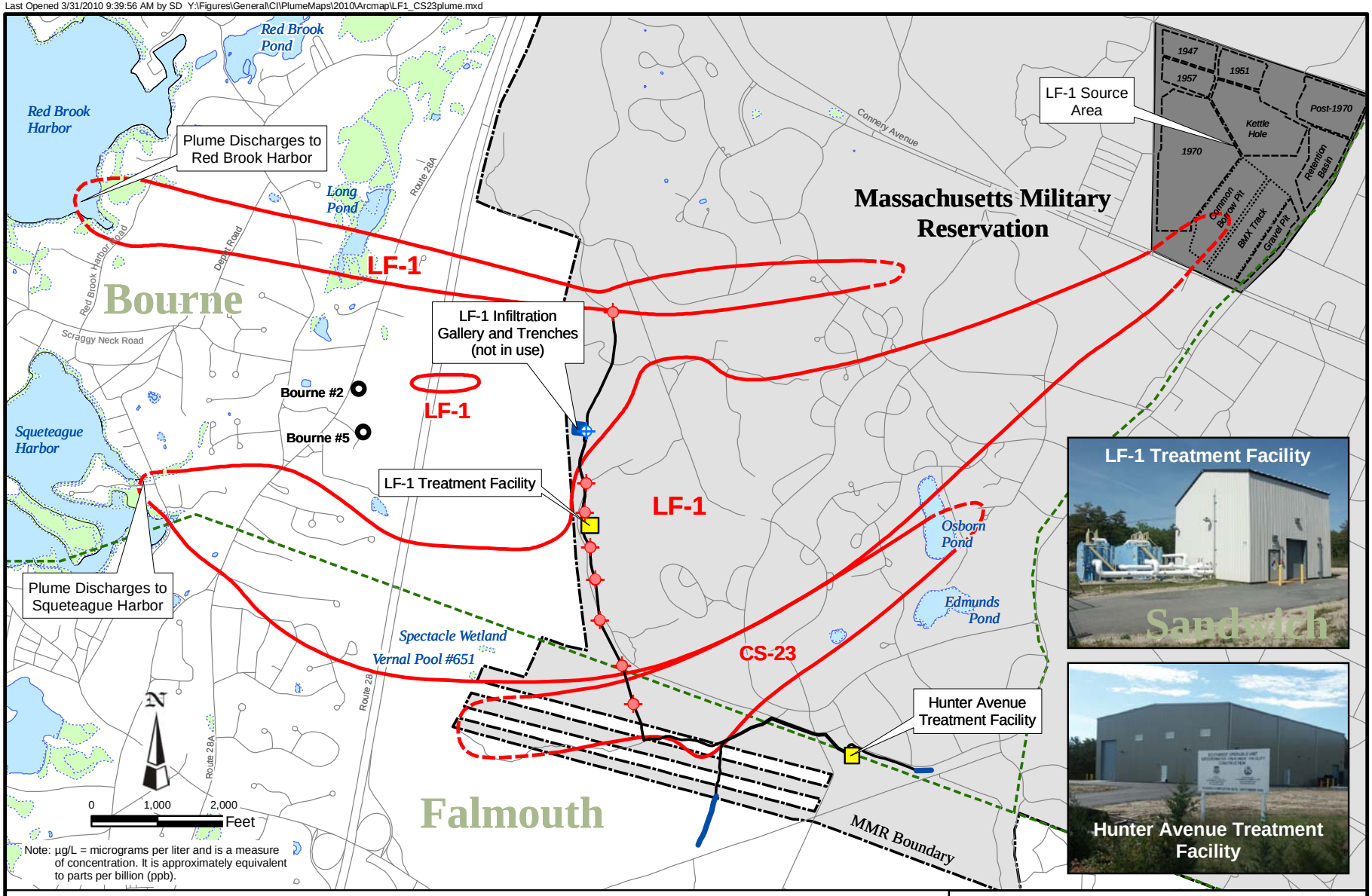

Legend

LF-1 and CS-23 Plume Boundary = Concentrations exceeding drinking water standards or Maximum Contaminant Level (MCL). (Dashed where inferred.)
Represents an exceedance of:
Trichloroethene (TCE): MCL = 5 µg/L
Perchloroethene (PCE): MCL = 5 µg/L
Carbon Tetrachloride (CCl_4): MCL = 5 µg/L
1,4-Dichlorobenzene (1,4-DCB): MCL = 5 µg/L
1,1,2,2-Tetrachloroethane (1,1,2,2-TeCA): GW-1 = 2 µg/L
Vinyl Chloride (VC): MCL = 2 µg/L
Ethylene Dibromide (EDB): MMCL = 0.02 µg/L

Extraction Well
Reinjection Well
Public Water Supply Well
Source Area
BMX/Borrow Pit
Treatment Facility
Massachusetts Military Reservation Boundary
Town Boundary
Infiltration Gallery/Trench
Bog/Wetland

Data Source: AFCEE, March 2010, AFCEE-MMR Data Warehouse

Air Force Center for Engineering and the Environment

LANDFILL-1 (LF-1) AND CHEMICAL SPILL-23 (CS-23) PLUMES APRIL 2010

AFCEE - Massachusetts Military Reservation

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Legend

- Chlorinated Solvents Plume - Concentrations Exceed MCLs TCE = 5.0 µg/L PCE = 5.0 µg/L
- EDB Plume - Concentrations Exceed MMCL = 0.02 µg/L
- Perchlorate Plume - Concentrations Exceed MMCL = 2.0 µg/L
- RDX Plume - Concentrations exceed EPA 10^{-6} risk-based level = 0.6 ppb
- Plumes with Remedy in Place
- Plumes with Interim Remedy in Place
- Extraction Well
- Extraction Well (Off)
- Reinjection Well
- Reinjection Well (Off)
- Outflow Bubbler
- Treatment Facility
- Municipal Water Supply Well
- Town Boundary
- Infiltration Trench/Gallery

Treatment System Pipeline:

Influent — Effluent

Scale: 1 inch = 1 mile

0 0.5 1 Miles

The areas of contamination show the combined contaminants of concern within each plume.

Cape Cod Bay
Cape Cod Canal
Phinney's Harbor
Pocasset Harbor
Hen Cove
Red Brook Harbor
Squeteague Harbor
Megansett Harbor
Wild Harbor
Deep Pond
Crooked Pond
Coonamessett Pond
Jenkins Pond
Long Pond
Peters Pond
Snake Pond
Weeks Pond
Wakeby Pond
Mashpee Pond
Moody Pond
Ashumet Pond
Johns Pond

Bourne
Falmouth
Mashpee
Sandwich

Route 6
Route 130
Route 28
Route 151
Canal View Rd
Gibbs Rd
Barlow Rd
Jefferson Rd
Wood Rd
Greenway Rd
Quaker Meetinghouse Rd
Pew Rd
Frank Perkins Rd
Turpentine Rd
Connery Rd

Northwest Corner
Demolition Area 2
Central Impact Area
Western Boundary
Demolition Area 1
Massachusetts Military Reservation
L Range
Ashumet Valley

CS-19
CS-10
CS-23
CS-21
CS-20
CS-4
LF-1
FS-1
FS-12
FS-28
FS-29
J-1
J-2
J-3

Several FS-12 extraction wells are turned off (not shown at this scale)

Shallow Well Point system is off

Surface water from Long Pond is also used as a drinking water source for the town of Falmouth

Contaminant of Concern (COC)	Type of Contaminant	Risk-Based Level
TCE – trichloroethene	solvent	MCL = 5 µg/L
PCE – perchloroethene	solvent	MCL = 5 µg/L
CCl_4 – carbon tetrachloride	solvent	MCL = 5 µg/L
EDB – ethylene dibromide	fuel-related compound	MMCL = 0.02 µg/L
benzene	fuel-related compound	MCL = 5 µg/L
vinyl chloride	solvent	MCL = 2 µg/L
1,1,2,2-tetrachloroethane	solvent	GW-1 = 2 µg/L
1,4-dichlorobenzene	solvent	MCL = 5 µg/L
manganese	metal	EPA Health Advisory = 300 µg/L
thallium	metal	MCL = 2 µg/L
lead	metal	15 µg/L (treatment technique action level for water distribution systems)
toluene	fuel	MCL = 1,000 µg/L
RDX - hexahydro-1,3,5-trinitro-1,3,5-triazine	explosive	HA = 2 µg/L GW-1 = 1 µg/L 10^{-6} = 0.6 µg/L
perchlorate	oxidizer	HA = 15 µg/L MMCL = 2 µg/L

MCL – Maximum Contaminant Level
MMCL – Massachusetts Maximum Contaminant Level
HA – Federal Lifetime Health Advisory
GW-1 – State default cleanup value to be used in lieu of site-specific risk-based level
10^{-6} – EPA level resulting in an excess cancer risk of one in a million

Note: ppb = parts per billion and is a measure of concentration. It is approximately equivalent to micrograms per liter (µg/L).

Massachusetts Military Reservation Groundwater Findings

Issued April 2010

FS-1 and FS-12 Groundwater Plumes

The source of the Fuel Spill 1 (FS-1) groundwater plume is the Aviation Gas Fuel Valve Test Dump Site in the eastern part of the base. The site was used from 1955 to 1970 to test fuel dump valves on EC-121 Super Constellation aircraft, which involved the release of fuel directly onto the ground. Currently no significant levels of COCs are present in the surface or subsurface soils at the FS-1 source area, and the source area groundwater is sampled for lead only.

The FS-1 groundwater plume contains the fuel additive ethylene dibromide (EDB) at levels above the MMCL, which is 0.02 µg/L. The FS-1 plume is currently in long-term remediation with a groundwater extraction-and-treatment system in the Quashnet River cranberry bog area, just northeast of Johns Pond. The system was designed to prevent upwelling of EDB contamination into the Quashnet River and associated cranberry bogs. The treatment plant uses granular activated carbon to remove EDB from the groundwater, which is then discharged to the Quashnet River through a series of oxygenating bubblers. The latest test results showed that the FS-1 treatment system has been successful in reducing both the amount of EDB in the FS-1 plume and the EDB concentrations in the surface water of the Quashnet River and associated bogs. A 2000 ROD specifies active treatment of the plume along with monitoring.

The source of the FS-12 groundwater plume was an estimated 70,000-gallon release from a section of a now-abandoned fuel pipeline that ran from the Cape Cod Canal to MMR. EDB is the only remaining contaminant above cleanup standards in the FS-12 groundwater plume. The source area groundwater is currently being monitored, after having undergone subsurface remediation in the 1990s. Groundwater sampling indicates that the source area has been successfully remediated. The pipeline has been cleaned and closed with state and federal regulatory approval.

The FS-12 plume is currently in long-term remediation with a groundwater extraction-and-treatment system. The treatment system consists of extraction wells, a treatment plant, and reinjection wells. The 2006 ROD called for the status quo of operating and monitoring the existing system. The latest test results indicate that the extraction wells continue to successfully contain the FS-12 groundwater plume, and the size of the plume has been reduced significantly. Land use controls are in place for the FS-1 and FS-12 plumes.

FS-1					
Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
April 2000	April 1999	2020	EDB	0.857	44.5 (October 2000)

Treatment Components in Operation[1]	# Treatment Plants	Treatment Rate (gpm) (original/current)[1]	Volume Treated (MG)[2]
Extraction Wells 3 Bubblers 3	1	750/515	3305.3

FS-12					
Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
September 2006	September 1997	2048	EDB	23.1	890 (November 1996)

Treatment Components in Operation[1]	# Treatment Plants	Treatment Rate (gpm) (original/current)[1]	Volume Treated (MG)[2]
Extraction Wells 4 Reinjection Wells 20	1	772/360	4082

ROD = Record of Decision, DD = Decision Document, µg/L = micrograms per liter, MG = million gallons, gpm = gallons per minute,
1. Current treatment rate as of April 1, 2010, 2. Through December 2009

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Note: Plumes depicted in this map other than FS-1 and FS-12 are not part of the IRP. For further information see: http://groundwaterprogram.army.mil, or call Pamela Richardson at (508) 968-5630, email pamela.j.richardson@us.army.mil

FS-12 Source Area

FS-12 Treatment Facility

FS-12

FS 12 Treatment Facility

Bourne

Snake Pond

JB Thompson Rd

Pimlico Pond Rd

Snake Pond Rd

Wakeby Pond

Connery Av

Massachusetts Military Reservation

Mashpee Pond

FS-1 Source Area

Mashpee

Bearses Road

Great Hay Road

FS-1

Moody Pond

Grafton Pocknet Road

Phinneys Road

Saddleback Road

FS-1 Treatment Facility

Johns Pond

Quashnet River

0 1,500 3,000 Feet

Legend

Data Source: AFCEE, March 2010, AFCEE-MMR Data Warehouse

- FS-1 and FS-12 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL). Represents an exceedance of ethylene dibromide (EDB) (EDB MMCL = 0.02 µg/L) (Dashed Where Inferred).
- Treatment System Piping
- Massachusetts Military Reservation Boundary
- Town Boundary

Note: µg/L = micrograms per liter and is a measure of concentration.It is approximately equivalent to parts per billion (ppb).

- Outflow Bubbler
- Extraction Well (On)
- Extraction Well (Off)
- Reinjection Well (On)
- Reinjection Well (Off)
- Treatment Facility
- Source Area
- BogWetland

Army Program Plumes

- Perchlorate Plume - Concentrations Exceed MMCL = 2.0 µg/L
- RDX Plume - Concentrations exceed EPA 10^{-6} risk-based level = 0.6 ppb

Air Force Center for Engineering and the Environment

FUEL SPILL-1 (FS-1) AND FUEL SPILL-12 (FS-12)
APRIL 2010

AFCEE - Massachusetts Military Reservation

CH2MHILL

CS-4, CS-20, CS-21, FS-28 and FS-29 Groundwater Plumes

Five groundwater plumes can be found in the area north and south of Route 151 in the town of Falmouth. They are FS-28, FS-29, CS-4, CS-20, and CS-21. Only CS-4 has a known source area, a former vehicle maintenance area and storage yard on the MMR. The other plumes were found to be disconnected from distinct source areas. They most likely originated somewhere in the southern portion of MMR, which contained various aircraft and vehicle maintenance shops, runways, and housing/personnel support facilities. Records indicate that spills and/or releases occurred in these areas in the past. COCs in the plumes are fuel and solvent-related contaminants. They include EDB, PCE, TCE, and CCl_4. The MMCL for EDB is 0.02 µg/L, while the MCL for the rest of the contaminants is 5 µg/L.

More than 18,000 tons of contaminated soil were treated on site at the CS-4 source area, and additional soil was transported off site for proper disposal. A groundwater extraction-and-treatment system began operating in 1993, but was later replaced by a more efficient system in 2006 to better capture the plume.

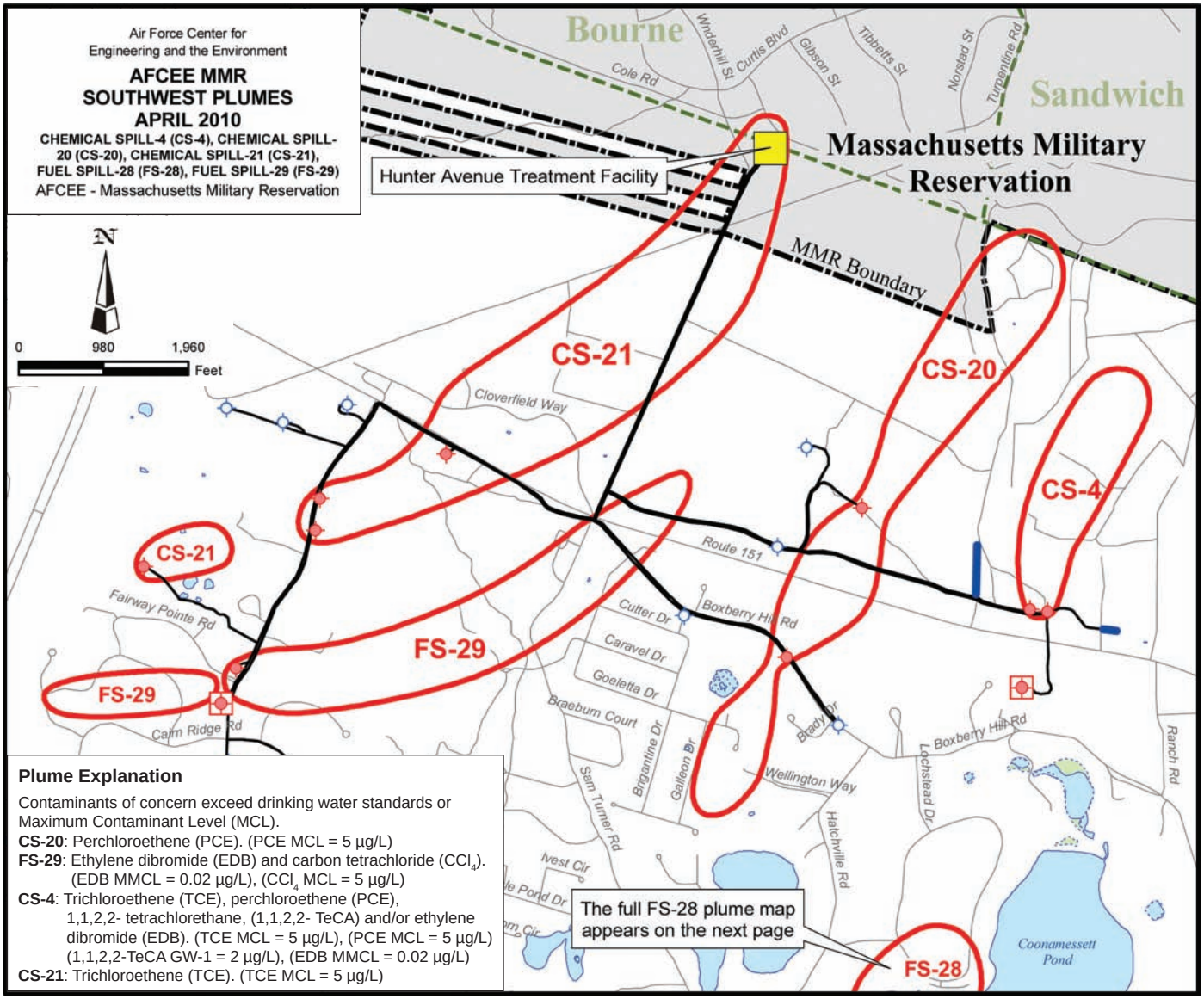
Portions of the FS-28 plume were first discovered in 1993 beneath the leading edge of the CS-4 plume. In 1996, groundwater investigations found EDB upwelling into the Coonamessett River in Falmouth. No EDB is presently detected in the Coonamessett River. The FS-28 plume is currently in long-term remediation with a groundwater extraction-and-treatment system. A treatment plant is located in a bog area just south of Hatchville Road and treated water is discharged to the Coonamessett River through two oxygenating bubblers. Shallow wellpoint extraction wells operated for several years but are no longer being used. In 2007 a new extraction well was installed to the south to address a deep lobe of EDB.

The FS-28 plume underflows Coonamessett Pond and has not affected the pond or a nearby Town of Falmouth municipal well. In 2002 AFCEE funded a $5.2 million wellhead treatment system to ensure a safe water supply for the Falmouth well. A ROD was issued in October 2000.

The FS-29, CS-20, and CS-21 groundwater plumes were discovered in the late 1990s. A ROD for FS-29 was issued in October 2000, and a ROD for CS-4, CS-20, and CS-21 was issued in February 2000. Since 2006, the FS-29, CS-4, CS-20, and CS-21 groundwater plumes have been undergoing active treatment through a series of extraction wells, reinjection wells, and infiltration trenches. Extracted plume water is treated with granular activated carbon at the Hunter Avenue Treatment Facility on base. Land use controls are in place for all these plumes.

Plume	Date of ROD or DD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2009 Highest Levels (µg/L)	Highest Historic Levels (µg/L)	
CS-4	February 2000 (ESD 9/2008)	November 2005	2014	TCE	5.5	19 (February 1997)	
				PCE	23.2	61 (February 1997)	
CS-20	February 2000 (ESD 9/2008)	January 2006	2017	PCE	20.5	98.1 (September 2005)	
CS-21	February 2000 (ESD 9/2008)	September 2006	2027	TCE	98	98.8 (June 2001)	
FS-28	October 2000 (ESD 9/2008)	October 1997	2047	EDB	1.38	18 (January 1997)	
FS-29	October 2000 (ESD 9/2008)	September 2006	2018	EDB	0.084	0.318 (May 2001)	

ROD = Record of Decision, DD = Decision Document, µg/L = micrograms per liter, MG = million gallons, gpm = gallons per minute,



Note: µg/L = micrograms per liter and is a measure of concentration. It is approximately equivalent to parts per billion (ppb).

Treatment Components in Operation[1]	# Treatment Plants	Treatment Rate (gpm)[1] (original/current)	Volume Treated (MG)[2]
Extraction Wells 2 Infiltration Trenches 2	1	620/199	1027
Extraction Wells 2 Reinjection Wells 4	1	775/773	1460
Extraction Wells 4 Reinjection Wells 3	1	1400/1395	2213
Extraction Wells 2 Bubblers 2	1	750/600	4304.5
Extraction Wells 1 Reinjection Wells 2	1	525/224	642

ESD = Explanation of Significant Differences, 1. Current treatment rate as of April 1, 2010, 2. Through December 2009

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Falmouth

Route 151

Deep Pond

Sam Turner Rd

Hatchville Rd

Plume Flows Under Pond

Round Pond

Coonamessett Pond

Coonamessett Water Supply Well

FS-28

Crooked Pond

Boxberry Hill Rd

Sandwich Rd

Hayway Rd

Outflow Bubbler

Thomas B Landers Rd

FS-28 Treatment Facility

Broad River

Outflow Bubbler

FS-28

Shallow Pond

Decommissioned Shallow Wellpoint Extraction System

Sam Turner Rd

FS-28

Sandwich Rd

Round Pond

Jenkins Pond

Pond 14

N

0 770 1,540

Feet

Legend

Data Source: AFCEE, March 2010, MMR-AFCEE Data Warehouse

FS-28 Plume Boundary = Concentrations exceeding drinking water standards or Massachusetts Maximum Contaminant Level (MMCL), dashed where inferred. Represents an exceedance of ethylene dibromide (EDB) (EDB MMCL = 0.02 µg/L)

Bog/Wetland

Treatment System Piping

Extraction Well

Outflow Bubbler

Public Drinking Water Supply Well

Treatment Facility

Note: µg/L = micrograms per liter and is a measure of concentration. It is approximately equivalent to parts per billion (ppb).

Air Force Center for Engineering and the Environment

FUEL SPILL 28 (FS-28) PLUME - APRIL 2010

AFCEE - Massachusetts Military Reservation

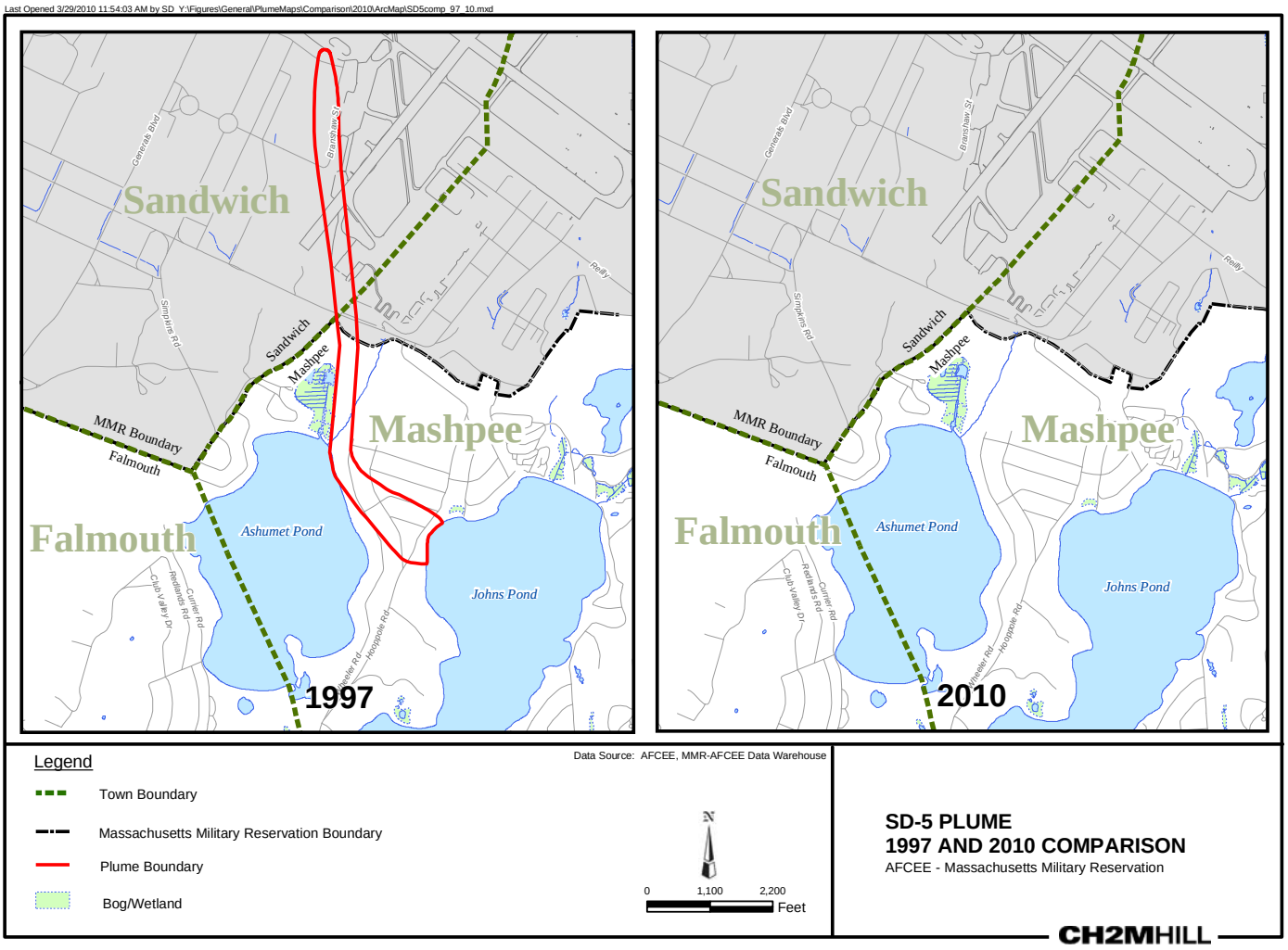
CH2MHILL

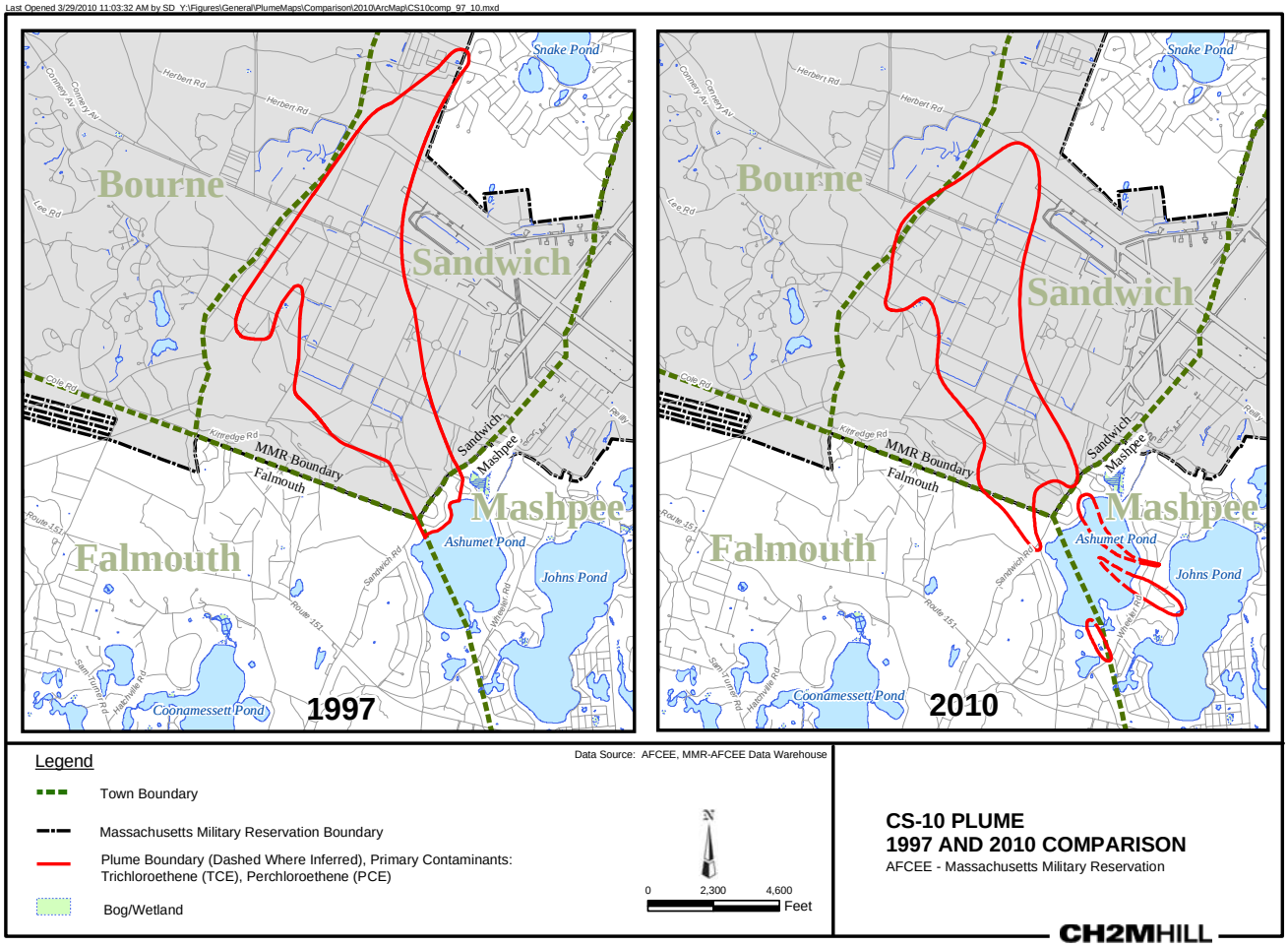
Progress Over The Years

Much progress has been made over the last 15 years. Program-wide, the source areas have been cleaned up and 11 groundwater plumes are undergoing pump-and-treat cleanup action both on and off base. All environmental cleanup decisions and remedies are in place. In the future the program will continue to monitor, adjust, and shut down treatment systems as cleanup progress is made. The Air Force will continue to conduct the most efficient cleanup operations while ensuring the protection of public health and the environment.

The SD-5 plume depiction illustrates the transformation of the plume over time due to the effect of cleanup systems used by the Air Force for several years. Contaminated water was cleaned by using two technologies. The first involved extracting the plume water, pumping it to a treatment building where large vessels of granular activated carbon removed the solvent contamination and then the clean water was returned to the ground through reinjection wells. Two recirculation wells were also used. Those involved two underground standalone treatment systems within the neighboring community. That technology used air and pumps to remove the solvents from the plume and capture them in carbon tanks. The plume has now been cleaned up to the point where only residual traces of solvent contamination are found in monitoring wells, which are periodically tested.

The following pages depict the cleanup progress of several IRP groundwater plumes over time. Most plumes show a significant reduction in size and contaminant mass. A few show a larger area which is related to plume information uncertainties in the early part of the cleanup program and changing conditions over time, a significant reason why diligent monitoring is required. For more information and depictions of all AFCEE groundwater plumes progress over time go to: http://www.mmr.org/Cleanup/plumes_fs.htm

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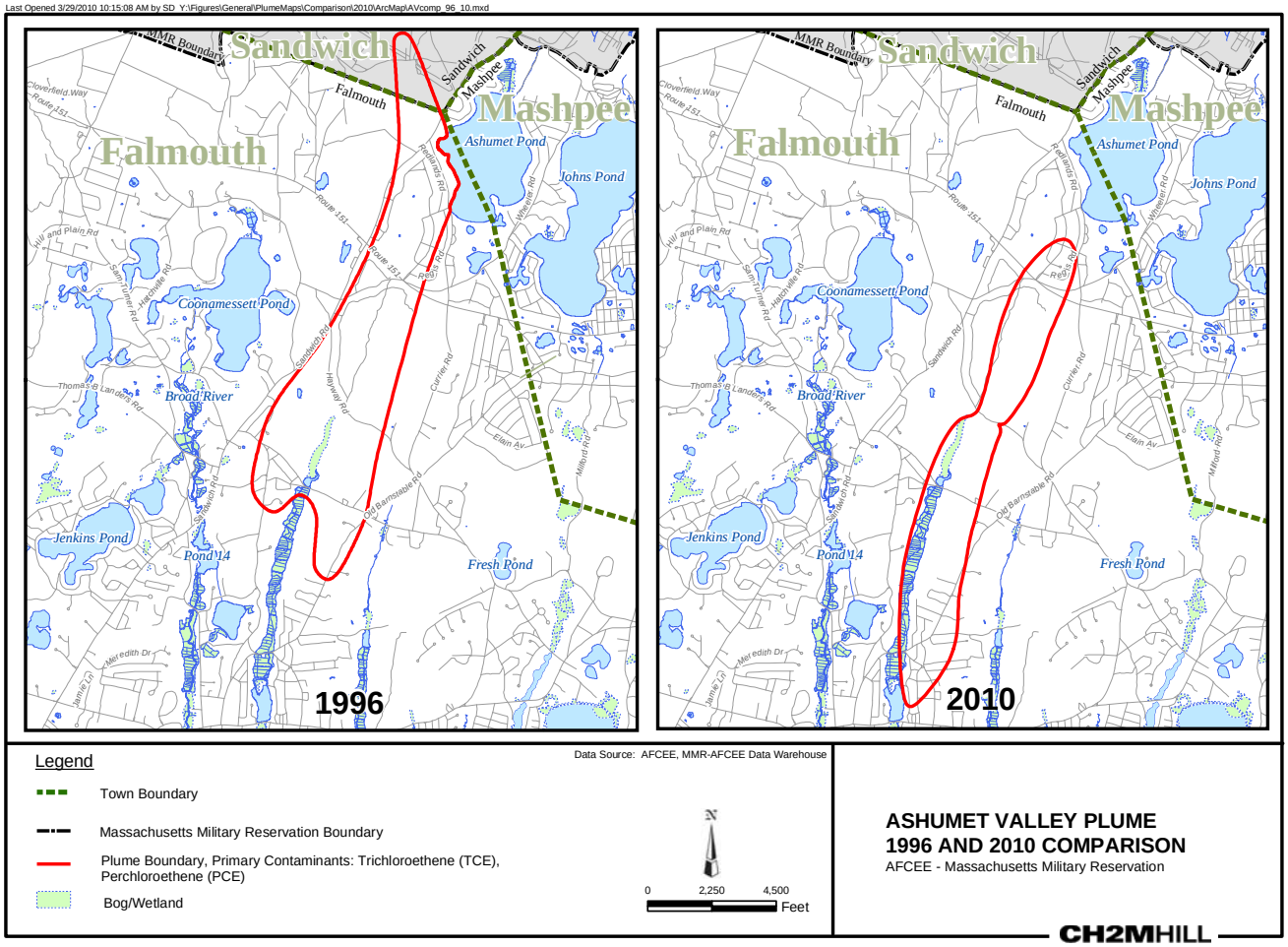
Bourne
Sandwich
Falmouth
Mashpee
Snake Pond
Ashumet Pond
Johns Pond
Coonamessett Pond
MMR Boundary
1997
2010
Legend
Town Boundary
Massachusetts Military Reservation Boundary
Plume Boundary (Dashed Where Inferred), Primary Contaminants: Trichloroethene (TCE), Perchloroethene (PCE)
Bog/Wetland
Data Source: AFCEE, MMR-AFCEE Data Warehouse
N
0 2,300 4,600
Feet
CS-10 PLUME
1997 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation
CH2MHILL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MMR Boundary
Sandwich
Falmouth
Mashpee
Ashumet Pond
Johns Pond
Coonamessett Pond
Broad River
Jenkins Pond
Pond 14
Fresh Pond
1996
2010
Legend
Town Boundary
Massachusetts Military Reservation Boundary
Plume Boundary, Primary Contaminants: Trichloroethene (TCE), Perchloroethene (PCE)
Bog/Wetland
Data Source: AFCEE, MMR-AFCEE Data Warehouse
N
0 2,250 4,500
Feet
ASHUMET VALLEY PLUME
1996 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation
CH2MHILL

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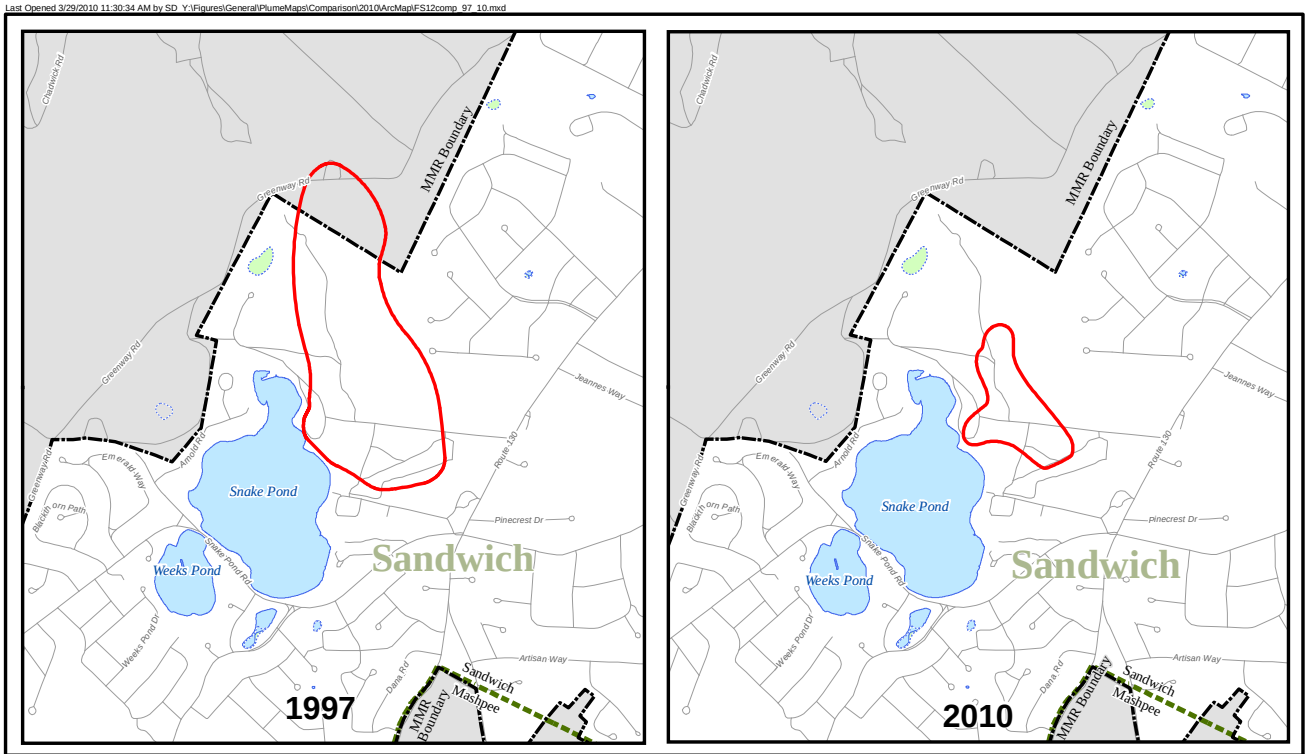

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary, Primary Contaminants: Benzene, Ethylene Dibromide (EDB)
- Bog/Wetland

Data Source: AFCEE, MMR-AFCEE Data Warehouse

0 960 1,920 Feet

FS-12 PLUME
1997 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation

CH2MHILL

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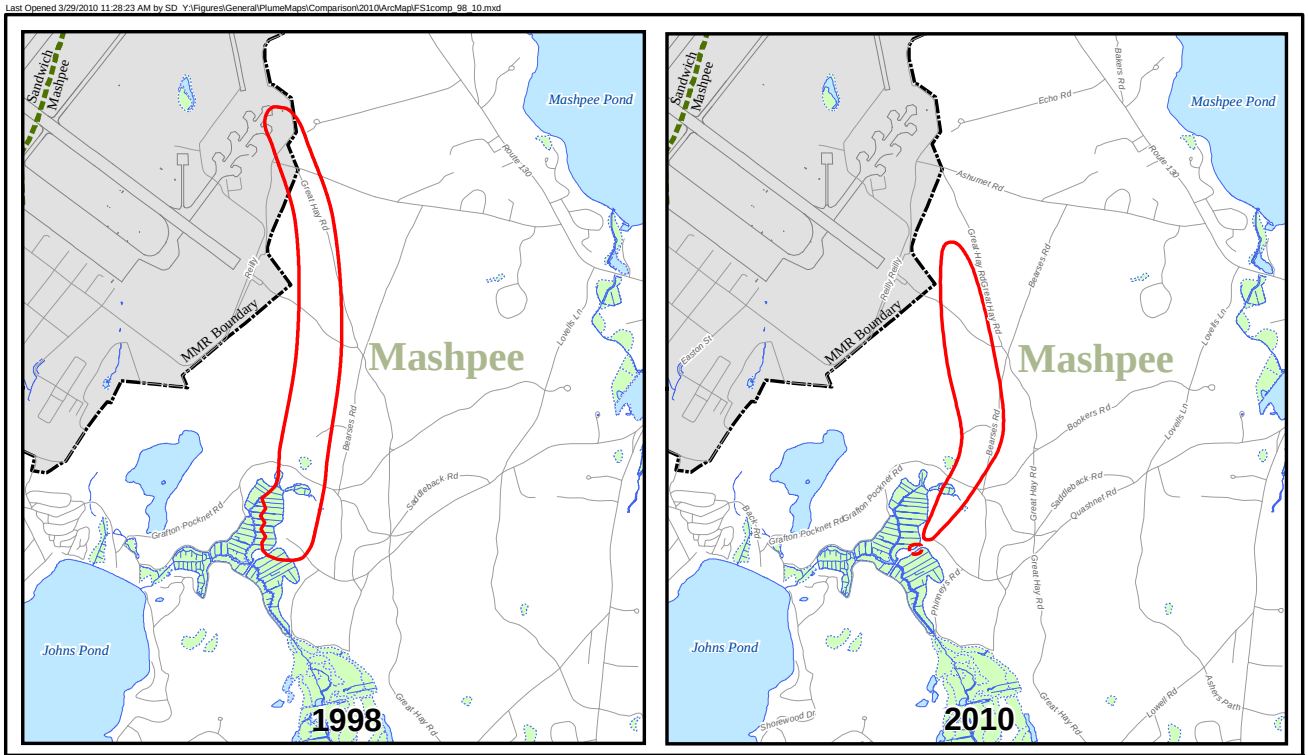


Legend

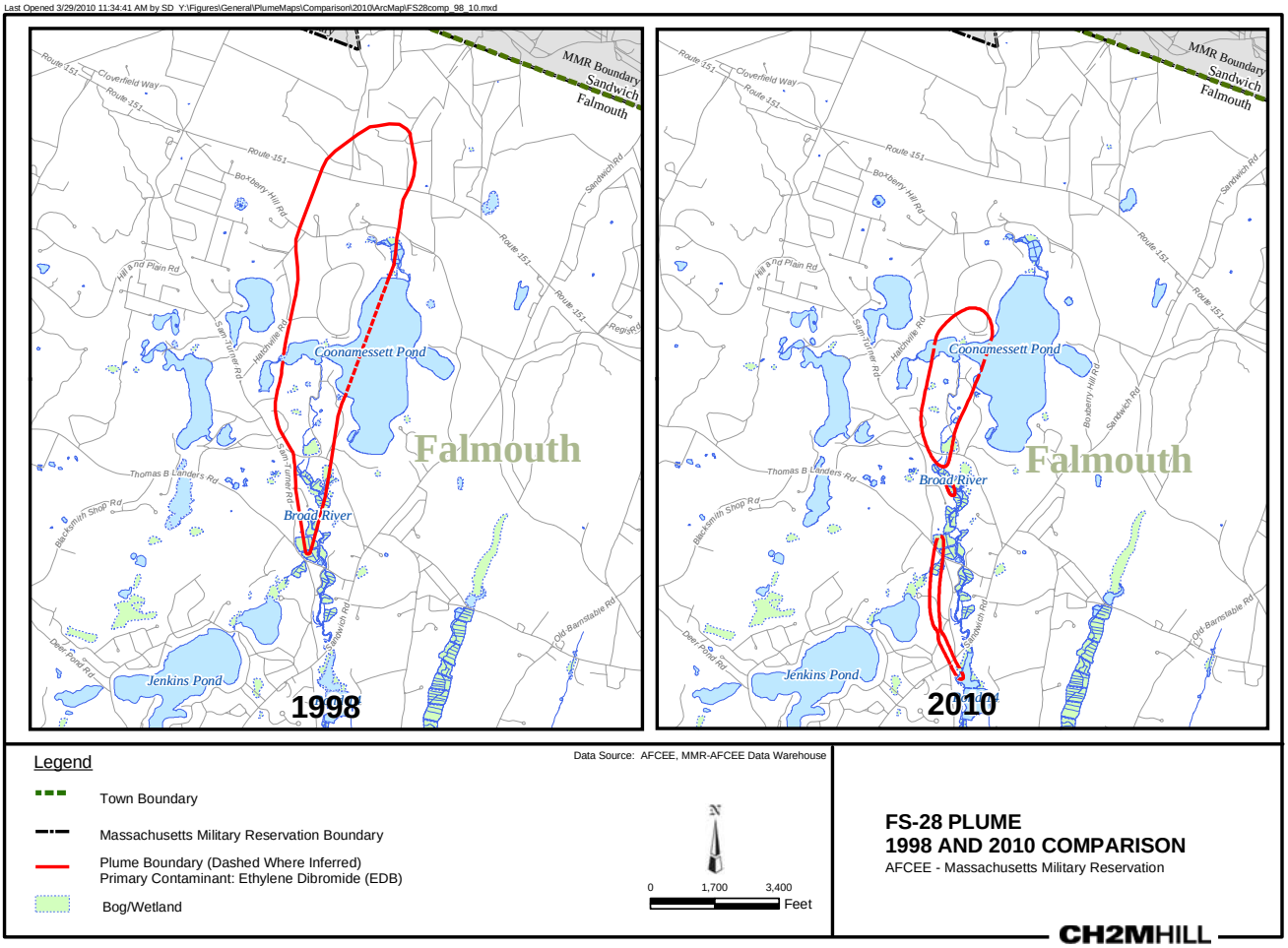
- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred), Primary Contaminant: Ethylene Dibromide (EDB)
- Bog/Wetland

Data Source: AFCEE, MMR-AFCEE Data Warehouse

0 1,000 2,000 Feet

FS-1 PLUME
1998 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation

CH2MHILL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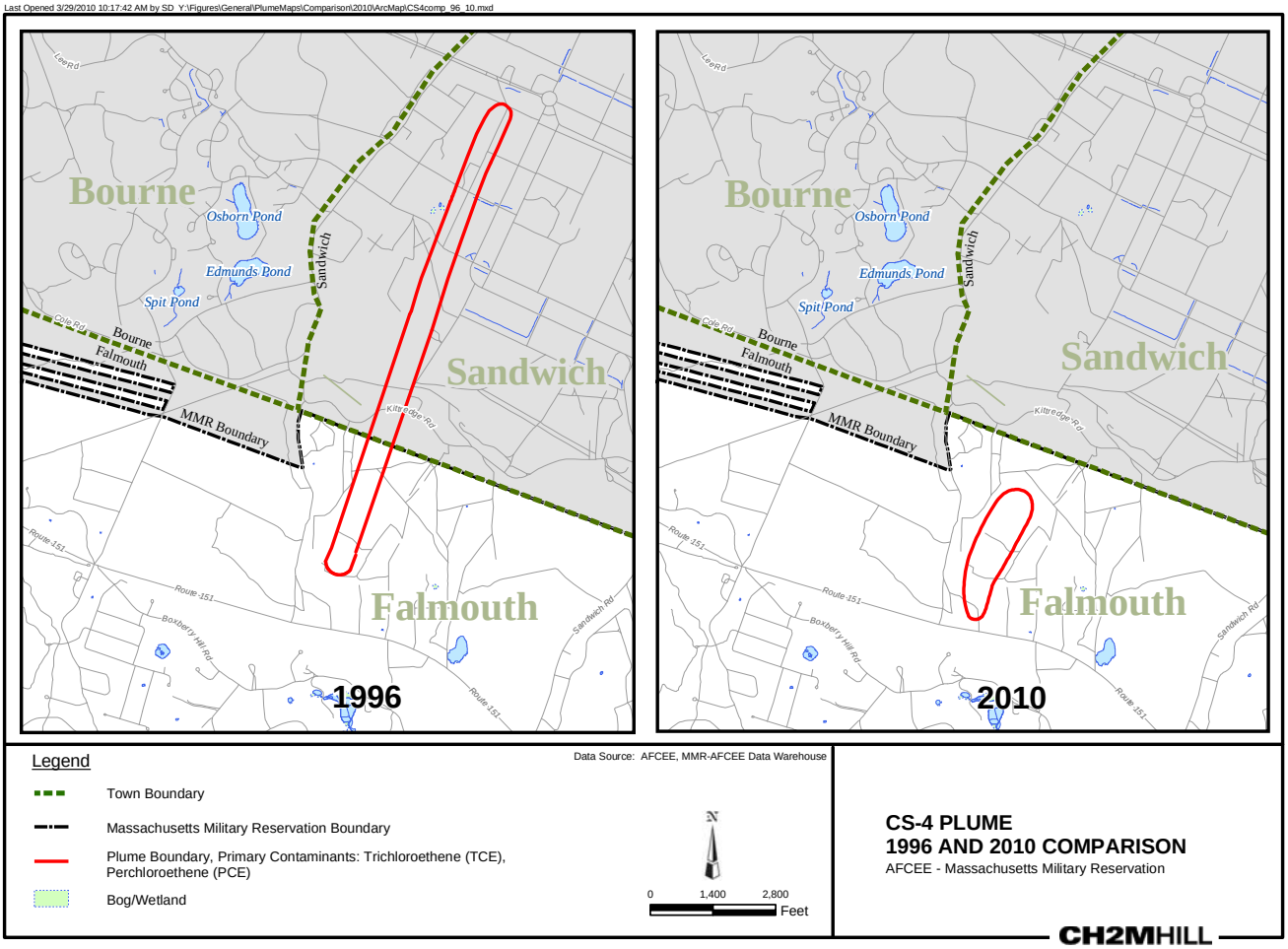
MMR Boundary
Sandwich
Falmouth
Coonamessett Pond
Falmouth
Broad River
Jenkins Pond
1998
2010
Legend
Town Boundary
Massachusetts Military Reservation Boundary
Plume Boundary (Dashed Where Inferred)
Primary Contaminant: Ethylene Dibromide (EDB)
Bog/Wetland
Data Source: AFCEE, MMR-AFCEE Data Warehouse
N
0 1,700 3,400
Feet
FS-28 PLUME
1998 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation
CH2MHILL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Bourne
Osborn Pond
Edmunds Pond
Spit Pond
Sandwich
Bourne
Falmouth
MMR Boundary
Sandwich
Falmouth
1996
2010
Legend
Town Boundary
Massachusetts Military Reservation Boundary
Plume Boundary, Primary Contaminants: Trichloroethene (TCE),
Perchloroethene (PCE)
Bog/Wetland
Data Source: AFCEE, MMR-AFCEE Data Warehouse
N
0 1,400 2,800
Feet
CS-4 PLUME
1996 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation
CH2MHILL

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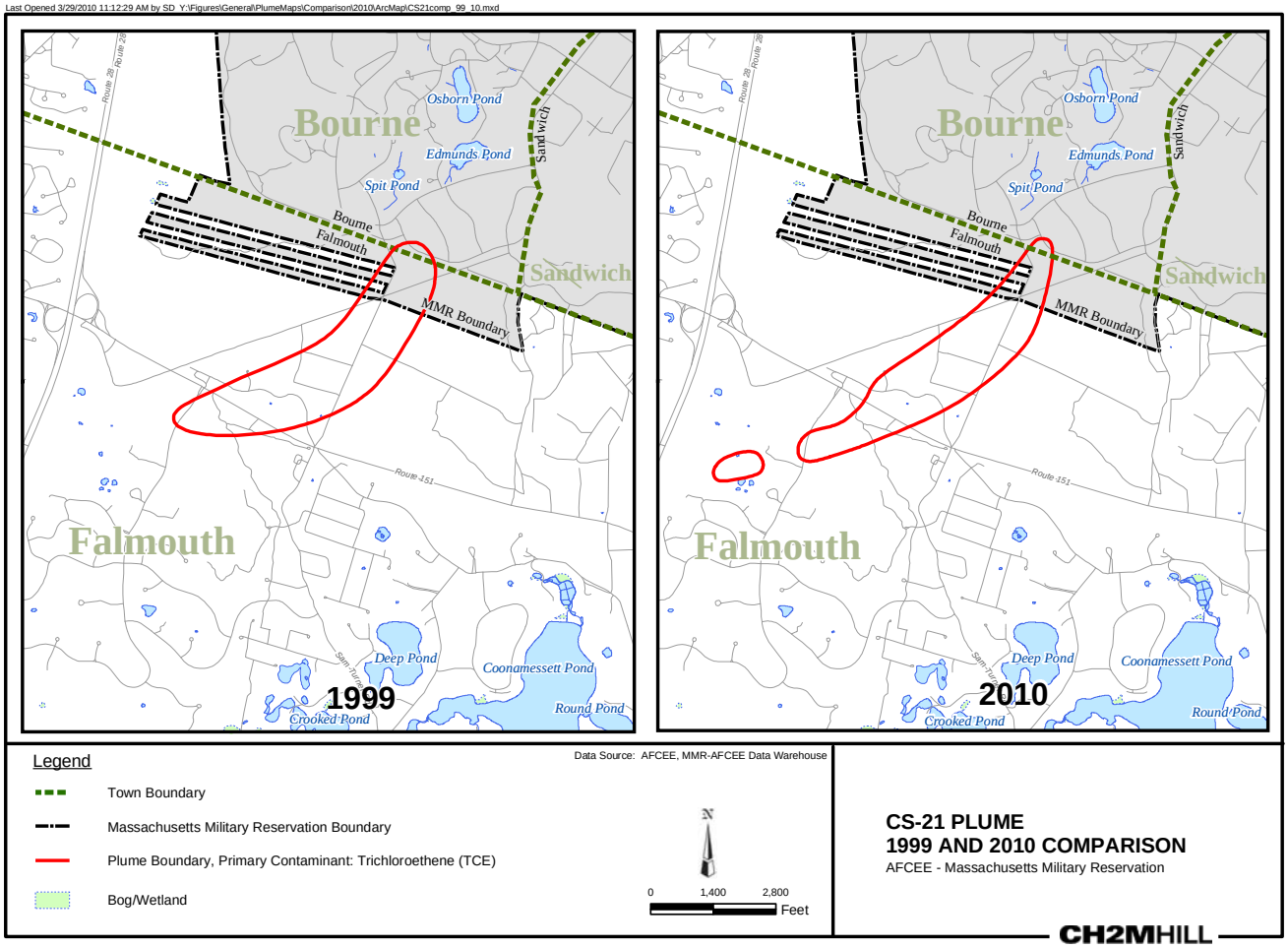

Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary, Primary Contaminant: Trichloroethene (TCE)
- Bog/Wetland

Data Source: AFCEE, MMR-AFCEE Data Warehouse

N

0 1,400 2,800 Feet

CS-21 PLUME
1999 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation

CH2MHILL

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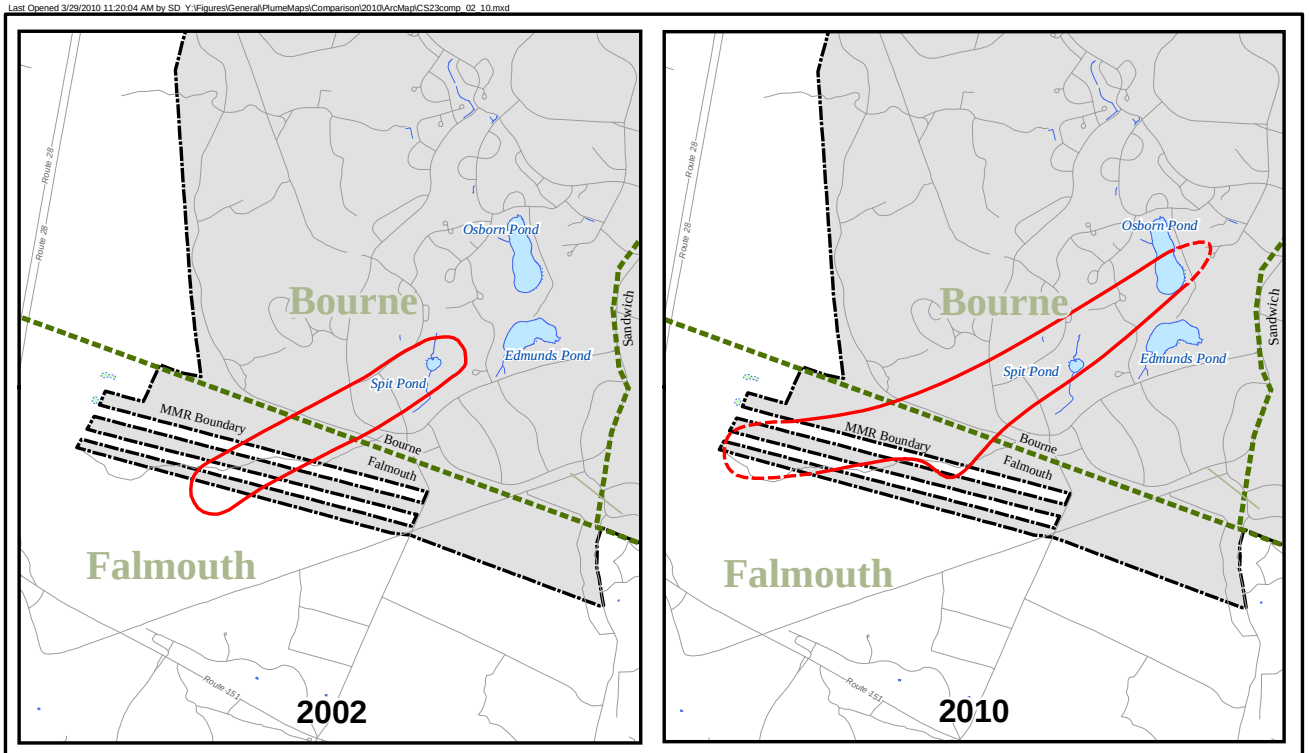


Legend

- Town Boundary
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred), Primary Contaminants: Trichloroethene (TCE), Carbon Tetrachloride (CCl_4)
- Bog/Wetland

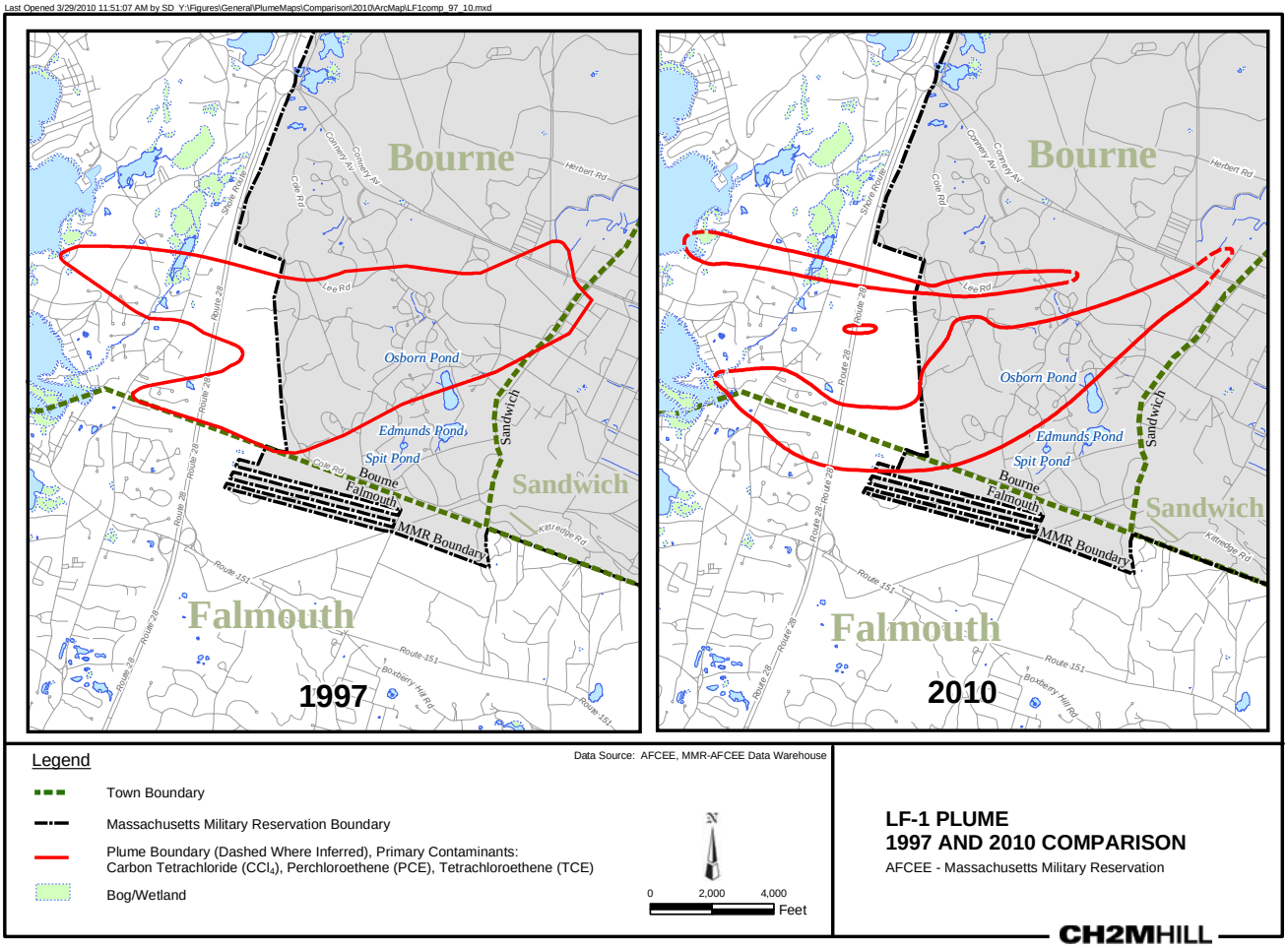
Data Source: AFCEE, MMR-AFCEE Data Warehouse

N

0 1,000 2,000 Feet

CS-23 PLUME
2002 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation

CH2MHILL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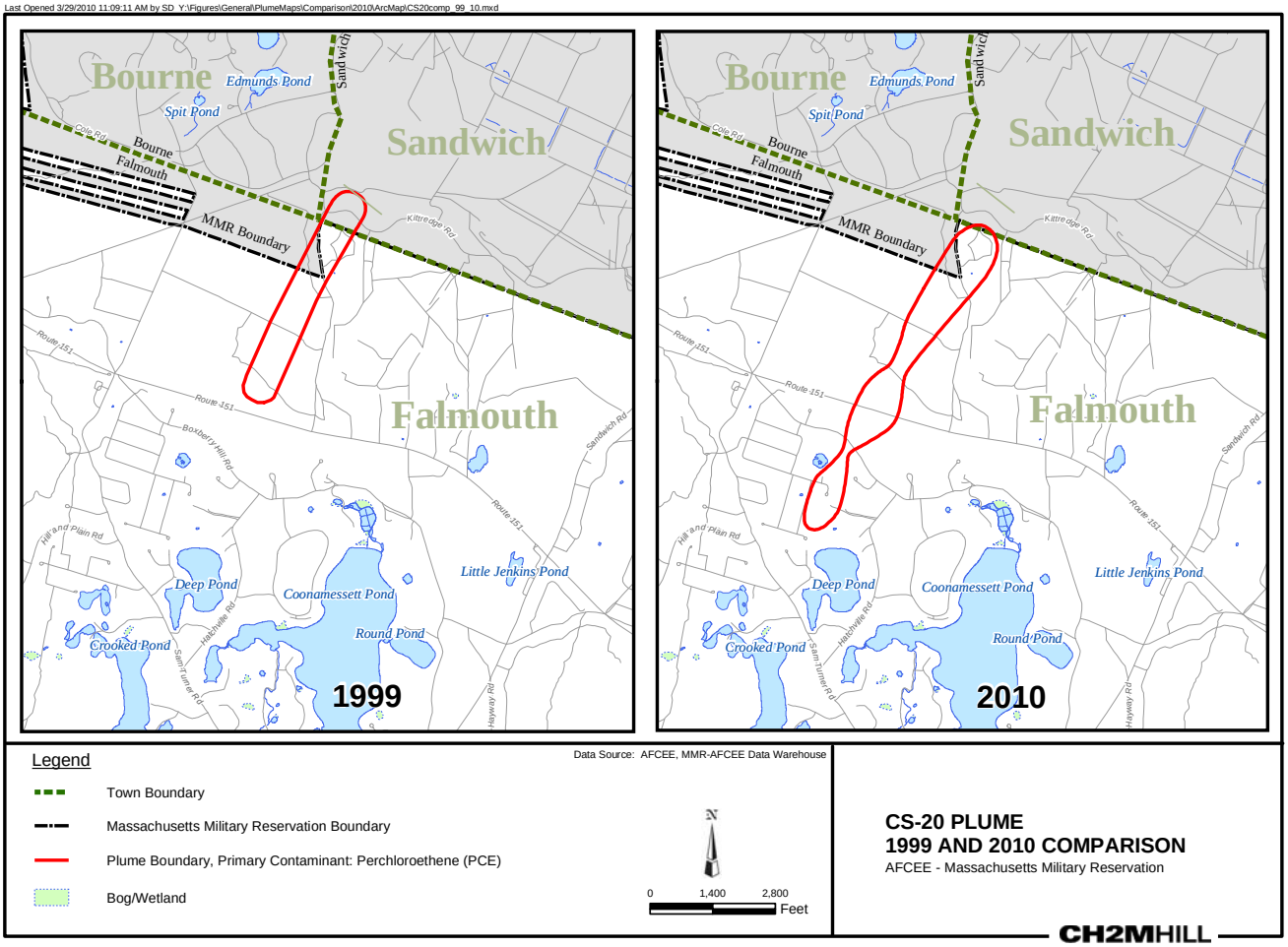
Bourne
Sandwich
Falmouth
Osborn Pond
Edmunds Pond
Spit Pond
Bourne Falmouth
MMR Boundary
1997
2010
Legend
Town Boundary
Massachusetts Military Reservation Boundary
Plume Boundary (Dashed Where Inferred), Primary Contaminants: Carbon Tetrachloride (CCl_4), Perchloroethene (PCE), Tetrachloroethene (TCE)
Bog/Wetland
Data Source: AFCEE, MMR-AFCEE Data Warehouse
N
0 2,000 4,000 Feet
LF-1 PLUME
1997 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation
CH2MHILL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Bourne
Sandwich
Falmouth
Edmunds Pond
Spit Pond
Bourne Falmouth
MMR Boundary
Deep Pond
Coonamessett Pond
Little Jenkins Pond
Round Pond
Crooked Pond
1999
2010
Legend
Town Boundary
Massachusetts Military Reservation Boundary
Plume Boundary, Primary Contaminant: Perchloroethene (PCE)
Bog/Wetland
Data Source: AFCEE, MMR-AFCEE Data Warehouse
N
0 1,400 2,800 Feet
CS-20 PLUME
1999 AND 2010 COMPARISON
AFCEE - Massachusetts Military Reservation
CH2MHILL

Sustainable Remediation at the Massachusetts Military Reservation

In situ chemical oxidation operation

Zero-valent iron barrier along Ashumet Pond shoreline

AFCEE's aggressive optimization activities have resulted in a more sustainable remediation program at MMR. Our "better, cheaper, faster" approach is intended to expedite aquifer restoration and cleanup timeframes while reducing costs to the taxpayers and minimizing our carbon footprint. Optimization activities conducted by AFCEE at MMR include:

- Demonstrating alternative in situ technologies such as a passive zero-valent iron barrier. This barrier requires no O&M and was installed along the Ashumet Pond shoreline to help reduce phosphorus discharging into the surface water.

- Continuously adjusting groundwater remediation systems as the groundwater plumes change over time. For example, extraction wells are taken out of operation once the portion of the aquifer is cleaned up. In some cases, extraction wells are added if deemed necessary to expedite aquifer restoration and eliminate risks to human health and the environment. In other cases, flow rates at extraction wells are modified as needed and/or systems are pulse-pumped, and packers are installed in extraction wells to focus extraction stress on changing contaminant distribution. In one case, a reinjection well was converted to an extraction well when contamination was detected unexpectedly in monitoring wells outside of the delineated plume area.

- Installing variable frequency drives (VFDs) on extraction well pump motors to save energy and reduce wear and tear on pump/motor assemblies. In the absence of VFDs, extraction well pumps and motors are changed out by our well maintenance staff to appropriately size the pumps and motors to optimized flow rates at extraction wells, resulting in a reduction in unnecessary energy use. In addition, energy saving premium efficiency motors have been installed on booster and transfer pumps in treatment plants.

- Adjusting the number of monitoring locations, frequency of sampling, and analytes in the monitoring program as the remediation requirements are refined. Passive sampling techniques such as passive diffusion bags and Hydrasleeves® are used to the maximum extent possible to save time, reduce costs, and reduce impacts to the environment, as compared to conventional pumped sampling.

Passive sampling technique

Sustainable Remediation at the Massachusetts Military Reservation

- Recycling granular activated carbon, which is used in the treatment systems to remove the contaminants from the groundwater, through a process called reactivation. Our used carbon is removed from the vessels, reactivated off site, and returned to MMR for reuse.
- Providing treated water for beneficial reuse such as irrigating the Veterans Affairs cemetery and as a geothermal source for heating, ventilating, and air conditioning systems.
- Pilot-testing new technologies such as ozone and hydrogen treatment of plant influent water to determine if they can be used effectively to pretreat the water and extend the life of the carbon beds and/or reduce operating costs.
- Evaluating various types of carbon to determine if a more efficient product is available.
- Employing energy conservation measures such as efficient lighting, occupancy sensors, and programmable thermostats in treatment plants and administrative buildings and recycling products such as paper, tubing, batteries, and light bulbs to the maximum extent possible.
- Using biodiesel fuel and vegetable-based hydraulic oil to the maximum extent possible in our diesel powered equipment.
- Employing low impact direct-push technology to collect groundwater samples instead of using auger/sonic well drilling when viable. AFCEE owns and operates a direct-push rig that is track mounted, has a smaller footprint, uses environmentally sensitive biofuels, and is responsive. Not only is this method of drilling more sustainable than other methods, it is also less expensive, since the work is done by site staff. AFCEE/MMR holds the record depth achieved by direct-push drilling technology - 319 feet below ground surface.
- Optimizing power purchase agreements for additional cost savings, purchasing green energy, and participating in the New England energy demand response program.
- Accounting for costs, efficiency, and environmental impact of our program decisions. These activities are tracked and reported in quarterly optimization reports. These reports are available on the www.mmr.org website.

Irrigation at the VA cemetery

Low impact direct-push unit

Renewable Energy Wind Turbine

A major optimization effort completed last year was the installation of renewable energy in the form of a 1.5 MW Fuhrlaender wind turbine. The wind turbine started operating on December 2, 2009 and is expected to reduce AFCEE's annual $2 million electric cost by 25% to 30%. The wind turbine is also anticipated to offset air emissions, generated indirectly through the use of electricity from fossil fuel based power plants, by approximately 25% to 30%. Based on a range of utility cost projections and an estimate of the turbine's energy production, the $4.6 million wind turbine is anticipated to have a payback period between six and eight years.

Attendees at the AFCEE wind turbine dedication ceremony at the MMR on Nov. 2, 2009: Left, top to bottom: **Mr. Joe Orciuch**, Environmental Chemical Corporation Project Manager; **Mr. Bill Delahunt**, U.S. Congressman, 10th Congressional District of Massachusetts; **Mr. Ira W. Leighton**, Acting Regional Administrator, U.S. Environmental Protection Agency - New England; and **Mr. Ian Bowles**, Secretary, Executive Office of Energy and Environmental Affairs - Massachusetts.
Right, top to bottom: **Ms. Rose Forbes**, AFCEE Project Manager; **Major General Joseph C. Carter**, Adjutant General of Massachusetts; **Mr. Tad D. Davis, IV**, Deputy Assistant Secretary of the Army for Environment, Safety and Occupational Health; and **Mr. Mike McGhee**, Acting Deputy Assistant Secretary of the Air Force for Energy, Environment, Safety and Occupational Health.

For more information:

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