Assessment and Response to Per Fluoro Alkyl Substances in Groundwater and Soils in the Cape Cod Aquifer

License Site Professional Association
Monthly Meeting – Westborough, MA
March 14, 2017

Thomas C Cambareri, LSP, CGWP

CAPE COD COMMISSION

Presentation

- Cape Cod Commission and Water Resources
- PFAFs –PFOS and PFOA
- Site Background
- Local Water Supply Impacts from CECs
- Site Assessment and Interim Actions
- Regulatory Response
- Remedial Actions
- Related Issues

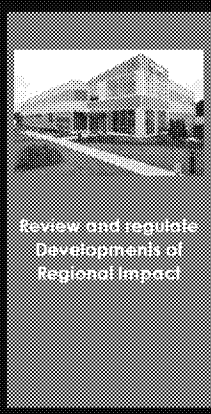
ED_002300_00001629-00001

MISSION OF THE CAPE COD COMMISSION

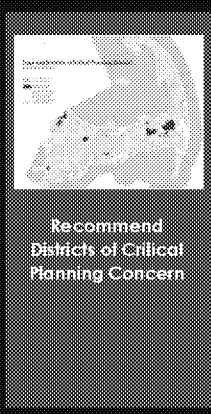
…To protect the unique values and quality of life on cape cod by coordinating a balanced relationship between environmental protection and economic progress.

Established in 1990

Prepare and oversee implementation of a Regional Policy Plan

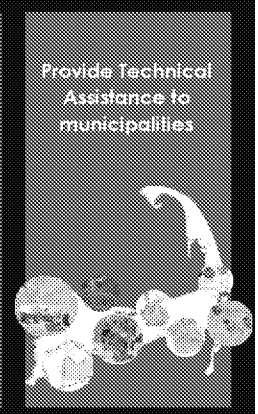


Review and regulate Developments of Regional Impact



Recommend Districts of Critical Planning Concern

Provide Technical Assistance to municipalities



Water Resources Goal of the Regional Policy Plan

Maintain a sustainable supply of high quality untreated drinking water and protect and restore the ecological integrity of fresh and marine surface waters.

Notable Water Resources Activities

- **Coordinate regional groundwater investigations and modeling with the USGS**
- **Coordinate Outer Cape Drinking Water Mngt**
- **Zone II Delineations and New Source Approval**
- **Coordinate the Mass Estuary Project (TMDLs)**
- **Establish Pond and Lakes Stewardship Program**
- **208 Water Quality Management Plan Update 2015**
- **General Technical Assistance / Policy / Regulation**

Contaminant Assessment / Cleanup

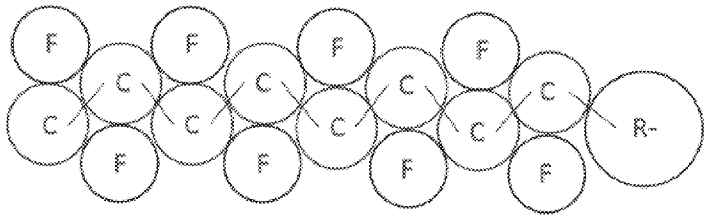
- **Hydrogeological plume delineations**
  - **Landfills**
  - **Wastewater Effluent**
  - **Non-Point Sources-Septic, fertilizer, golf**
- **Participate in MMR Cleanup (1990 to present)**
- **Registered as LSP in the initial 1993 class**
- **Manage the County's Fire Training Academy Site**
  - **Consultant 1986-1989**
  - **Internal County Staff (1989 to present)**

Poly and Per Fluorinated Alkyl Substances (PFAS)

- Per Fluorinated Compounds (PFCs)
  - Perfluorocarbons
  - PFAS

- PFAS – non-polymers Health Advisory
  - Perfluoro alkyl sulfonic acid (PFOS) 70 ng/l
  - Perfluoro octanolic acid (PFOA) 70 ng/l
  - Combination of the two 70 ng/l

CHEMISTRY[3]



Chemical properties:
- F highly electronegative
- F not polarizable
- F shields C
- C-F bond strength
- Weak intermolecular interactions

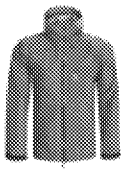
PFAS characteristics:
- Chemically stable
- Thermally stable
- Hydrophobic/lipophobic
- Surfactant properties
- Recalcitrant in environment

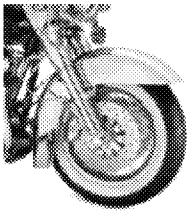
21

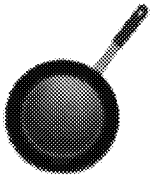
Source: NEWMOA May 2016 J. Guelfo

USES: OVERVIEW

Key Uses:
- Fluoropolymer manufacturing (e.g. polytetrafluoroethylene)
- Firefighting foams (e.g. aqueous film-forming foams)





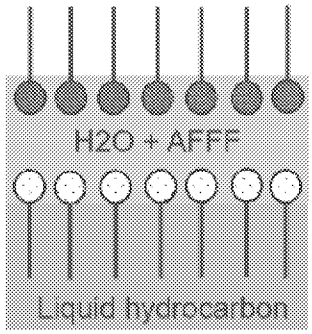


Other Uses:
- Electroplating
- Paper coating
- Stain/water repellants
- Textiles
- Electronics
- Insecticides/ herbicides
- Adhesives, paints, varnish
- Others too numerous to list

22

Source: NEWMOA May 2016 J. Guelfo

APPLICATIONS: A CLOSER LOOK AT AFFF[4,5]



PFAS (fluorocarbon surfactant)

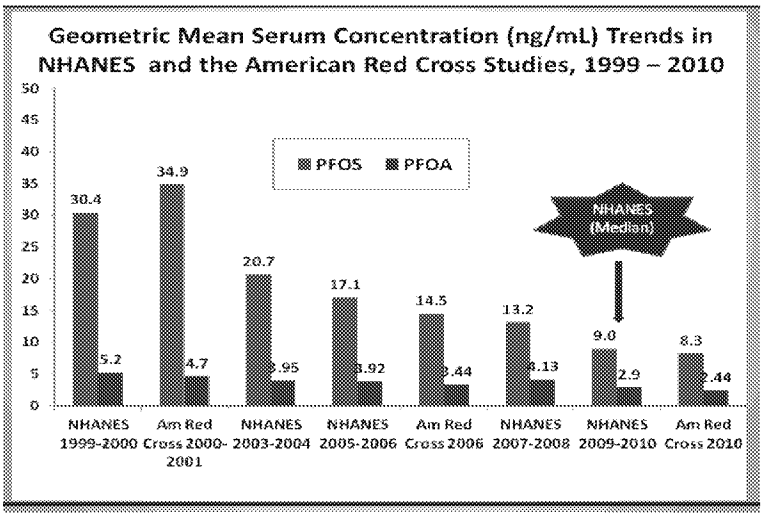
Hydrocarbon surfactant

AFFF and PFAS:

- 3M, 1980's-2000:
  - ~7-13 g/L PFCAs + PFSAs
  - 4.9-11.4 g/L PFOS
  - 0.5-1.4 g/L PFHxS
  - Negligible precursors
- 3M, National Foam, Buckeye, Chemguard, Ansul, 2000's-present:
  - Negligible PFCAs + PFSAs
  - Primarily precursors

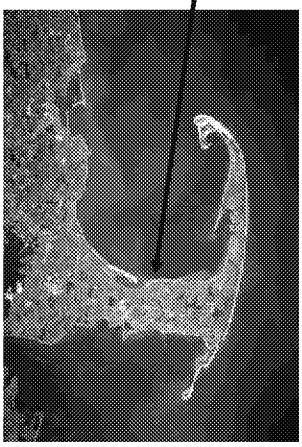
[4]Moody, Cheryl A., and Jennifer A. Field. ES&T. 34.18 (2000): 3864-3870.
[5]Houtz, Erika F., et al. ES&T 47.15 (2013): 8187-8195.

PFAS in Blood Serum 1999 to 2010



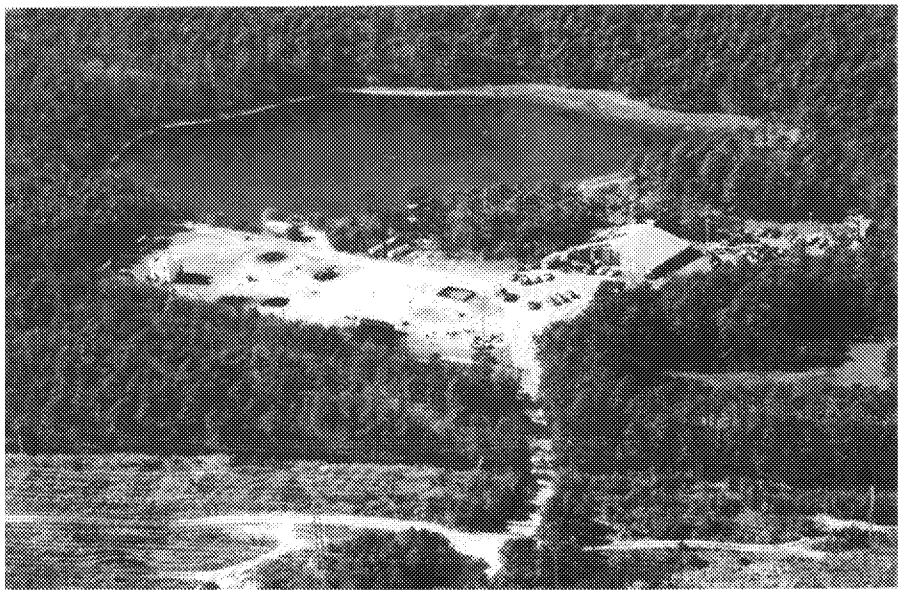
Site Locus Map

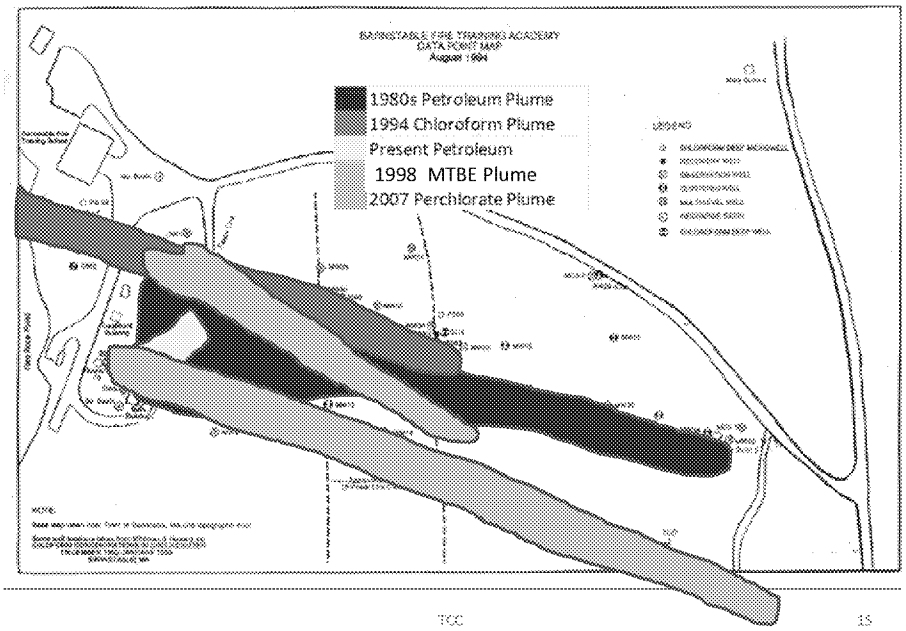
Cape Cod Mass

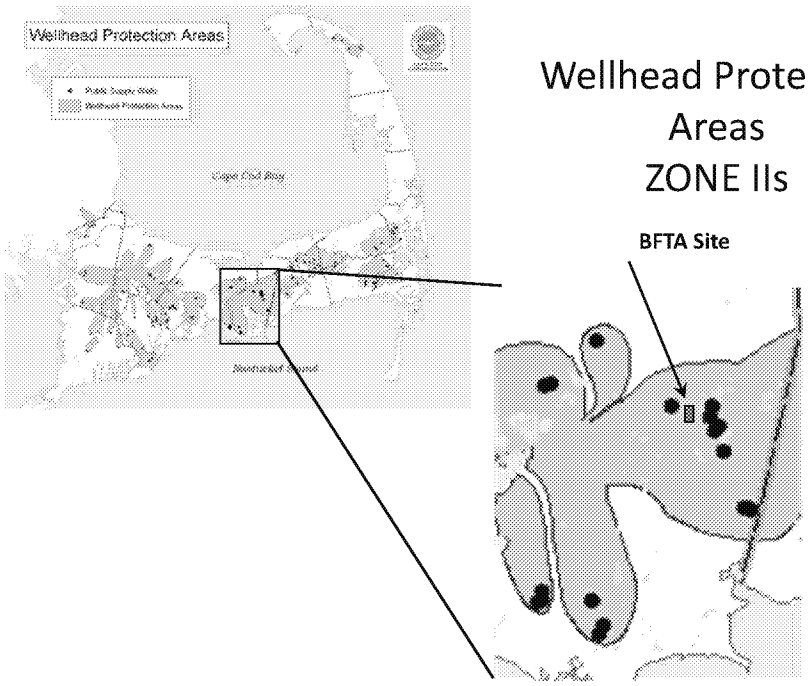


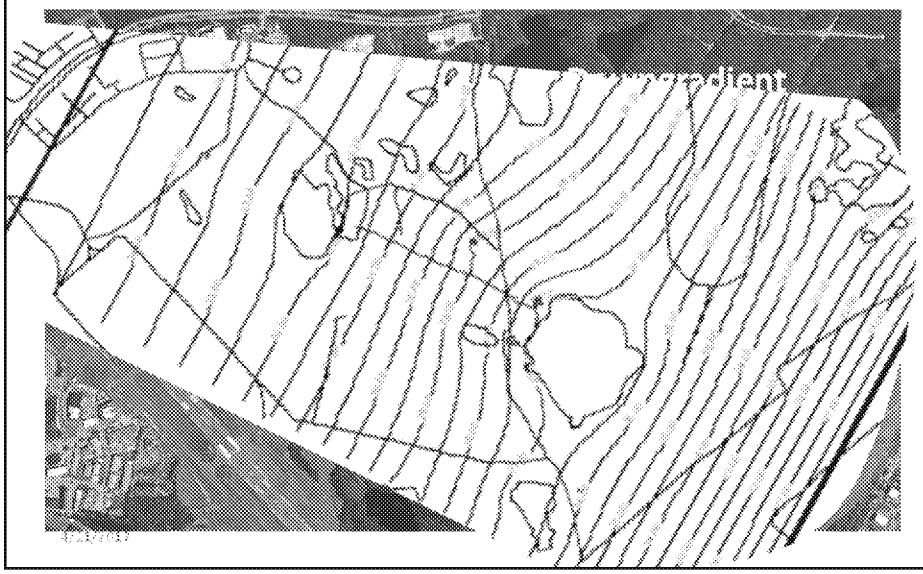
Barnstable County Fire Training Academy

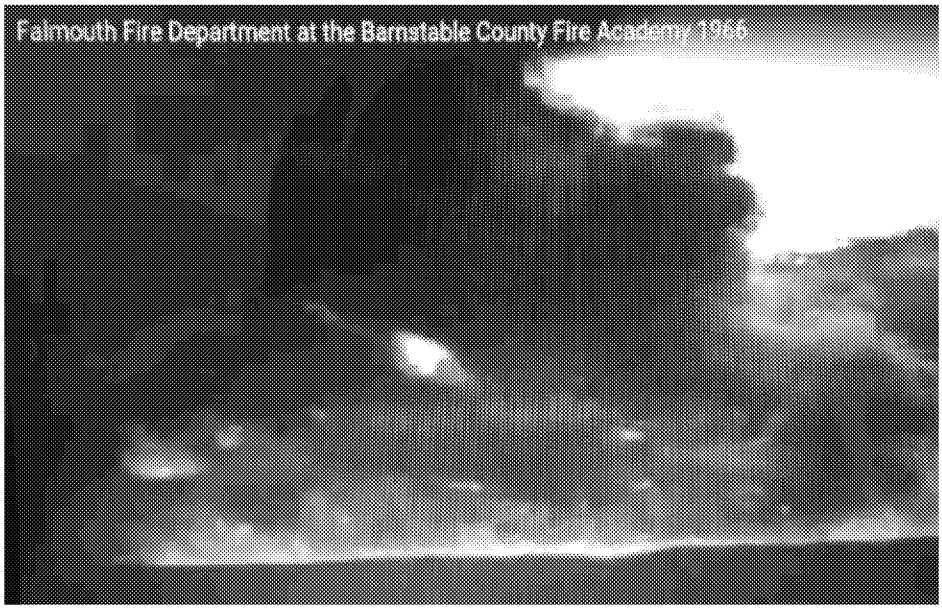
BFTA in late 1970's




1980s Petroleum Plume
1994 Chloroform Plume
Present Petroleum
1998 MTBE Plume
2007 Perchlorate Plume

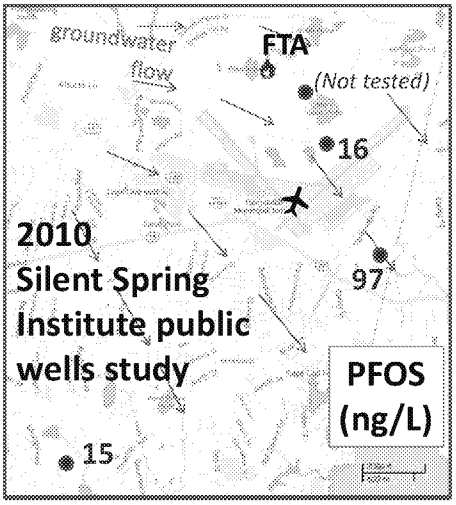

Wellhead Protection Areas
Wellhead Protection Areas
ZONE IIs
BFTA Site


gradient

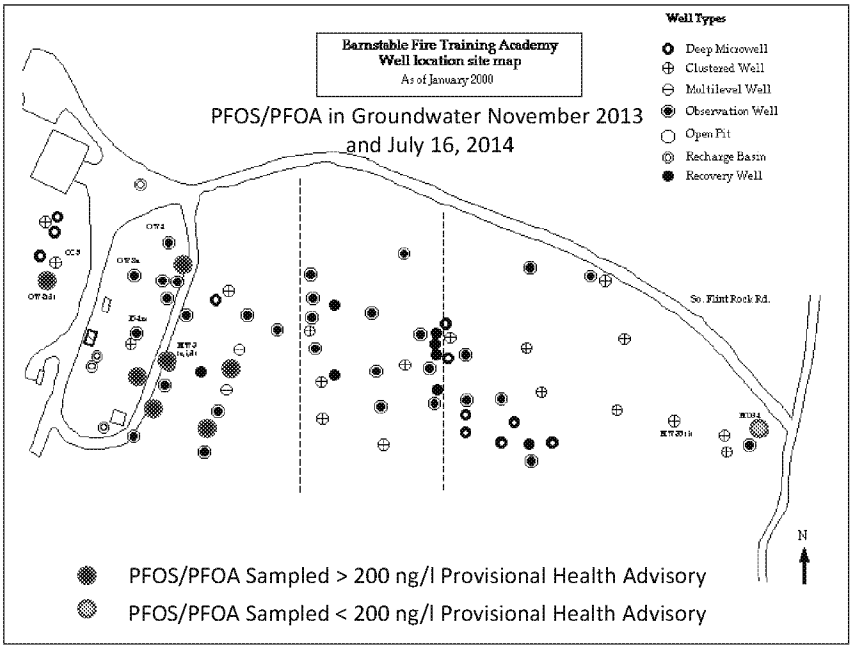

Falmouth Fire Department at the Barnstable County Fire Academy 1966

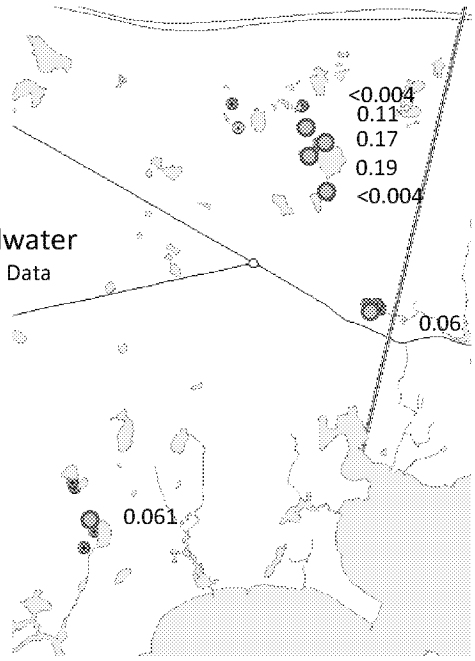
Where are PFASs coming from?

- Relatively high levels of PFASs in Hyannis wells likely linked to specific sources
  - Airports, fire training areas can be sources of PFASs into groundwater and surface waters



Laurel Schaider, Silent Spring Institute





PFOS in Groundwater

EPA UCMR 2013 Nov Data

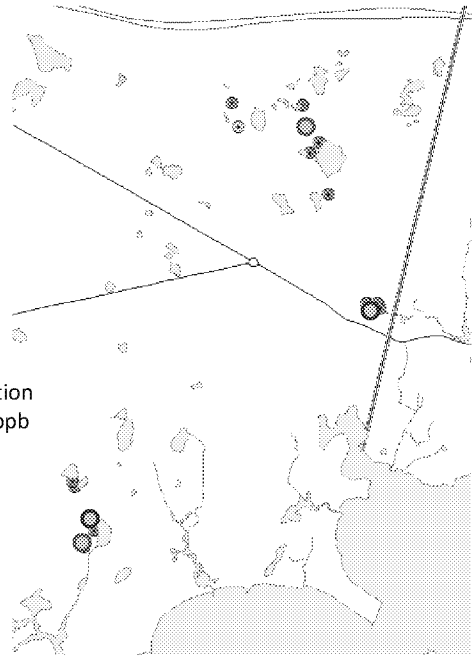
PFOS < 0.2

PFOS > 0.2

Safe Drinking Water Act

Unregulated
Contaminant
Monitoring
Rule

UCMR



1-4 Dioxane in Groundwater

2014

Dioxane Detection

Dioxane > 0.3 ppb

Safe Drinking Water Act

Unregulated
Contaminant
Monitoring
Rule

UCMR

County Response

- Unregulated Compound
- Identification > EPA Health Advisory
  - In Groundwater
  - In Public Supply Wells
- Assessment Fall 2014 -Spring 2015
- Identify Short Term Measures July 2015
- $232,000 for Remedial Actions Fall 2015
  - Activities outside of MCP
  - Applying the fundamental MCP strategy
- Obtains Legal Counsel 2016

DEP Response

- Assistance in Assessment to Town (Hyannis)
- Coordinated Meetings with Town and County
- Laboratory Sampling and Analysis
- Risk Assessment to for 1-4 Dioxane and PFAS

  May 8, 2015

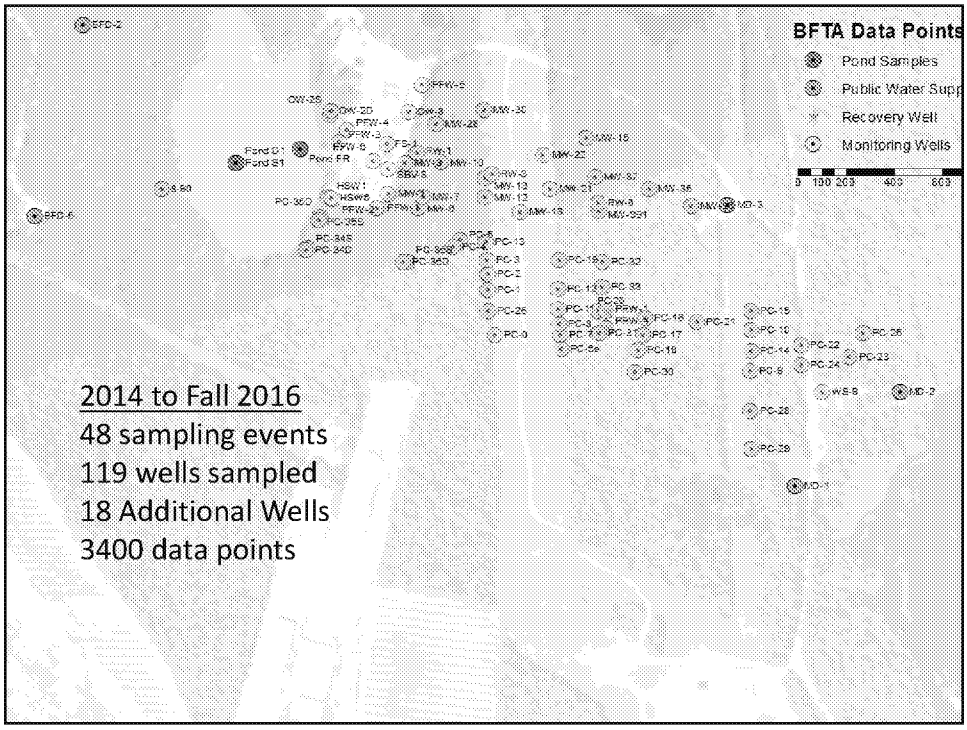
Because these risks are somewhat above the target levels and due to exceedances of health advisories, these findings support the town's decision to take the wells off-line. However, since the risks from the worst case exposure scenario are low, adverse health effects from the use of the system's water to date are unlikely. This memo provides a more in-depth assessment of risks had this water continued to be used.

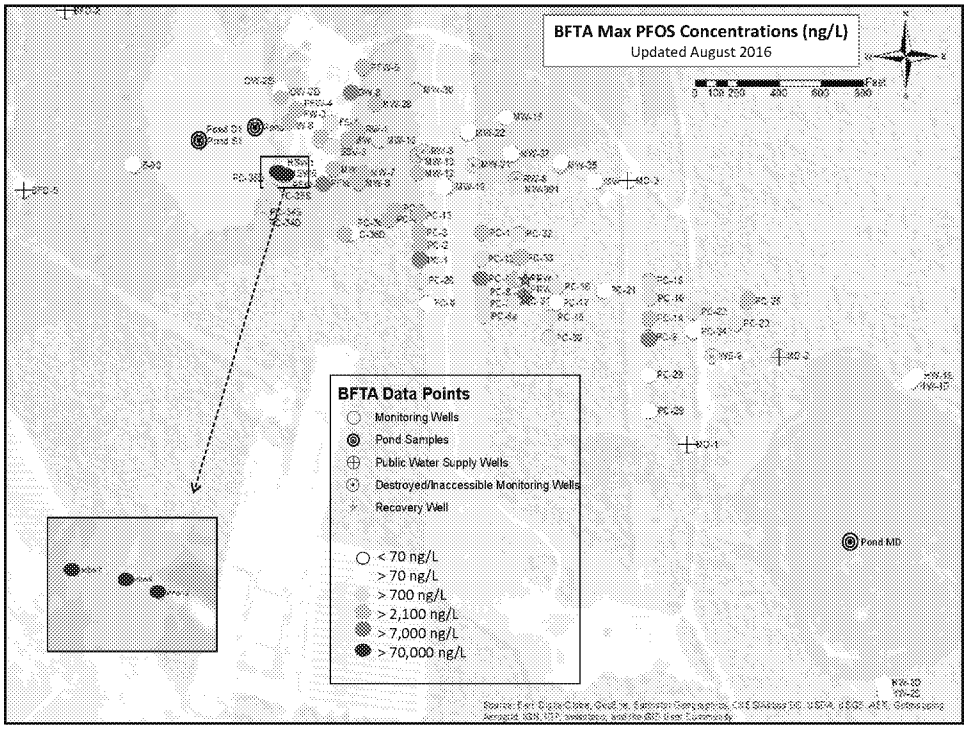
Town Response

- Installs Carbon Filters on Mary Dunn 1 and 2 wells –Operational July 2015
- Assesses Hyannis 1-4 Dioxane Issue
- Sues County for Treatment Costs for Mary Dunn Wells

Groundwater Investigation 2014-Present

April 2015


BFTA Data Points
Pond Samples
Public Water Supp
Recovery Well
Monitoring Wells
2014 to Fall 2016
48 sampling events
119 wells sampled
18 Additional Wells
3400 data points


BFTA Max PFOS Concentrations (ng/L)
Updated August 2016
BFTA Data Points
Monitoring Wells
Pond Samples
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< 70 ng/L
> 70 ng/L
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> 7,000 ng/L
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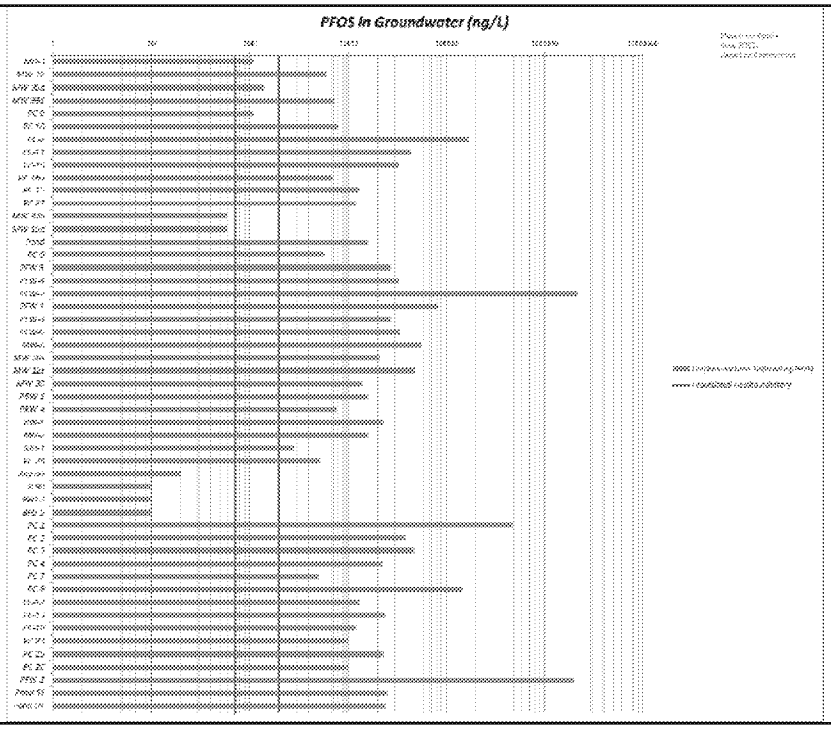
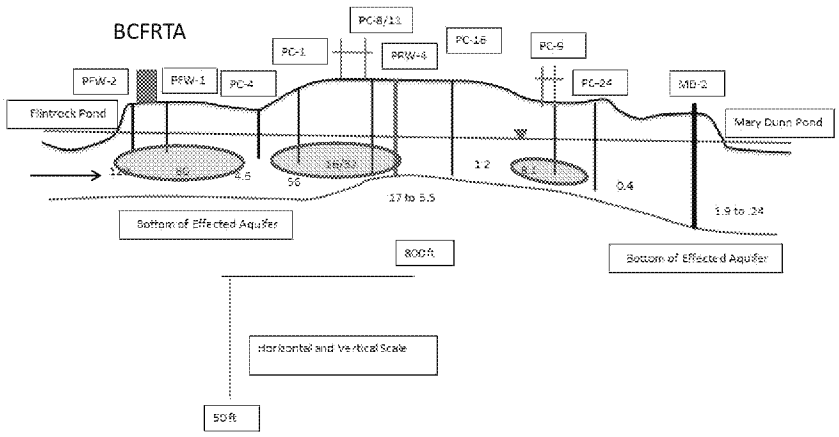
Pond MD



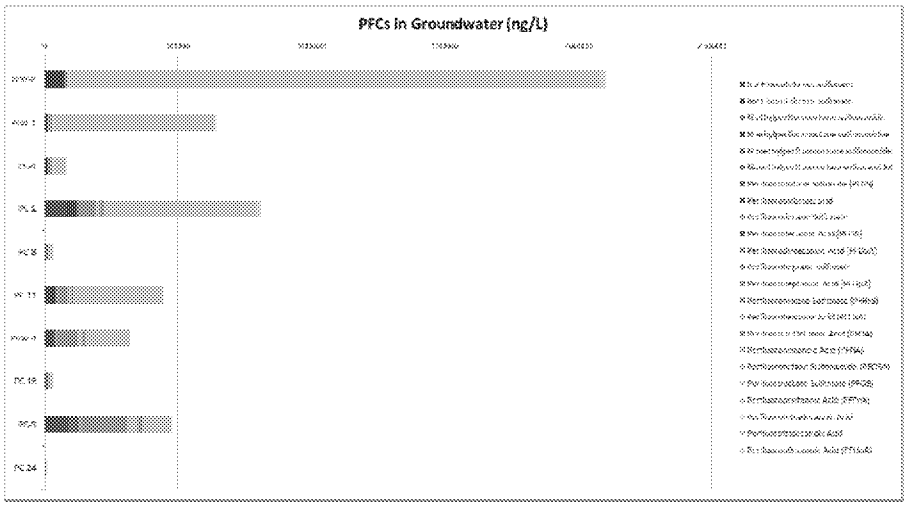
Groundwater PFAFs Detections

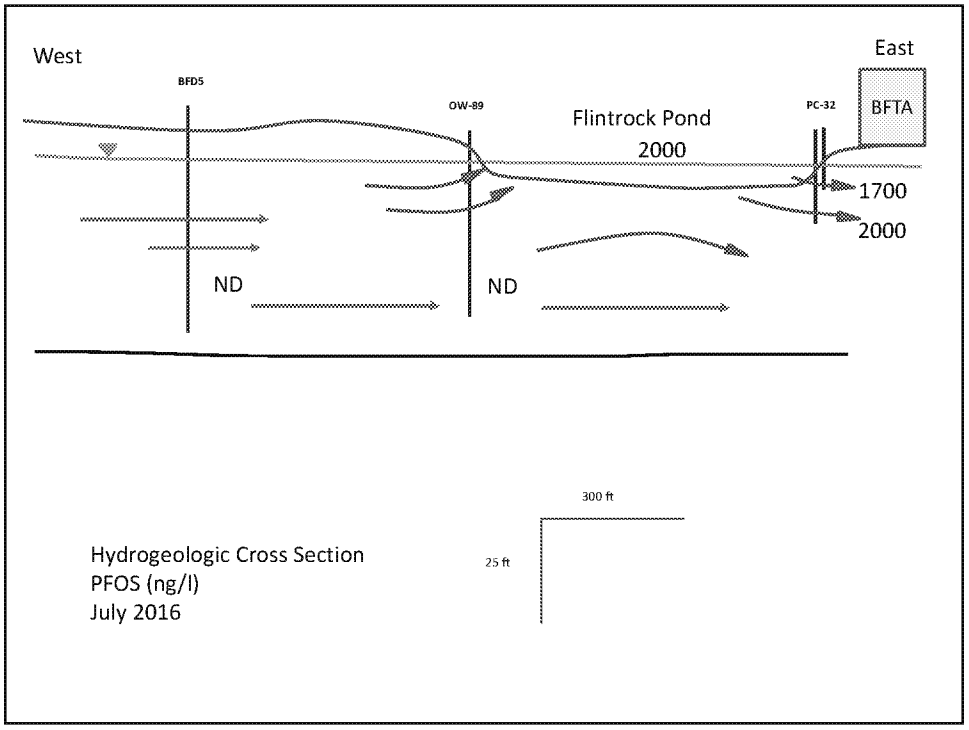
PFAS Compound	Maximum	Avgerage	Count	StdDev
6:2 Fluorotelomer sulfonate	16000	1200	137	2966
8:2 Fluorotelomer sulfonate	12000	549	137	1805
N-ethylperfluorooctane sulfonamide	0	0	137	0
N-ethylperfluorooctane sulfonamidoe	9	0	137	1
N-methylperfluorooctane sulfonamide	0	0	137	0
N-methylperfluorooctanesulfonamidol	6.5	0	137	1
Perfluorobutane Sulfonate (PFBS)	5100	160	203	486
Perfluorobutanoic acid	890	111	143	172
Perfluorodecane Sulfonate	530	13	143	71
Perfluorodecanoic Acid (PFDA)	540	18	148	75
Perfluorododecanoic Acid (PFDoA)	7.7	0	147	1
Perfluoroheptane sulfonate	5400	252	137	736
Perfluoroheptanoic Acid (PFHpA)	1600	159	204	223
Perfluorohexane Sulfonate (PFHxS)	51000	1750	203	4715
Perfluorohexanoic Acid (PFHxA)	6100	516	151	836
Perfluoro-n-Octanoic Acid (PFOA)	5200	249	229	552
Perfluorononanoic Acid (PFNA)	830	96	203	159
Perfluorooctane Sulfonamide (PFOSA)	240	8	143	23
Perfluorooctane Sulfonate (PFOS)	320000	10126	232	38408
Perfluoropentanoic Acid (PFPeA)	2300	326	143	437
Perfluorotetradecanoic Acid	8.2	0	147	1
Perfluorotridecanoic Acid	440	3	147	36
Perfluoroundecanoic Acid (PFUnA)	5600	220	148	749

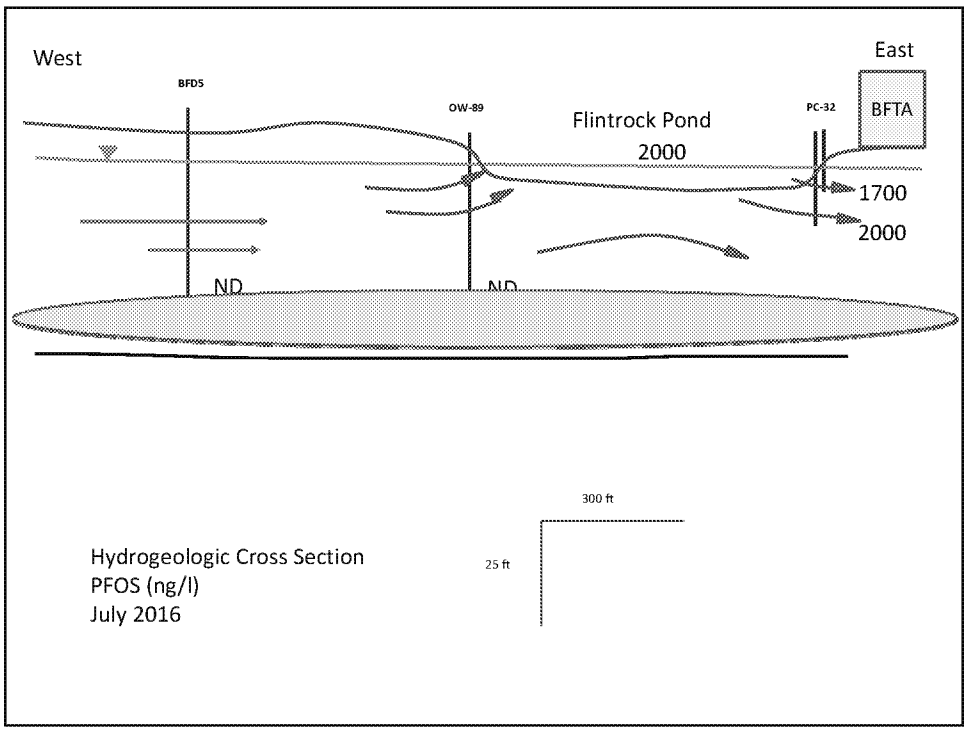


Hydrogeologic Cross Section showing PFOS in Groundwater (ppb)

May 3, 2016




West
East
BFD5
OW-89
Flintrock Pond
2000
PC-32
BFTA
1700
2000
ND
ND
300 ft
25 ft
Hydrogeologic Cross Section
PFOS (ng/l)
July 2016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East
BFD5
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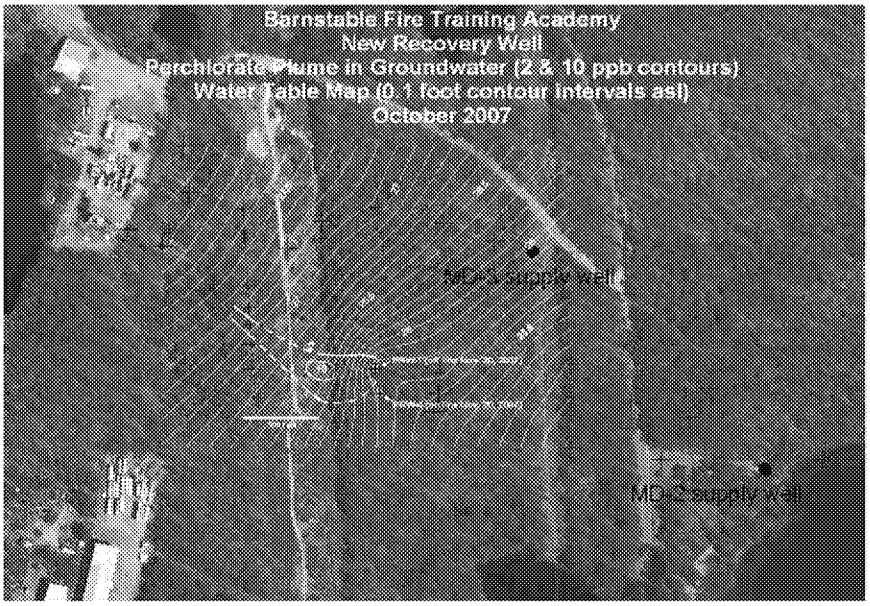
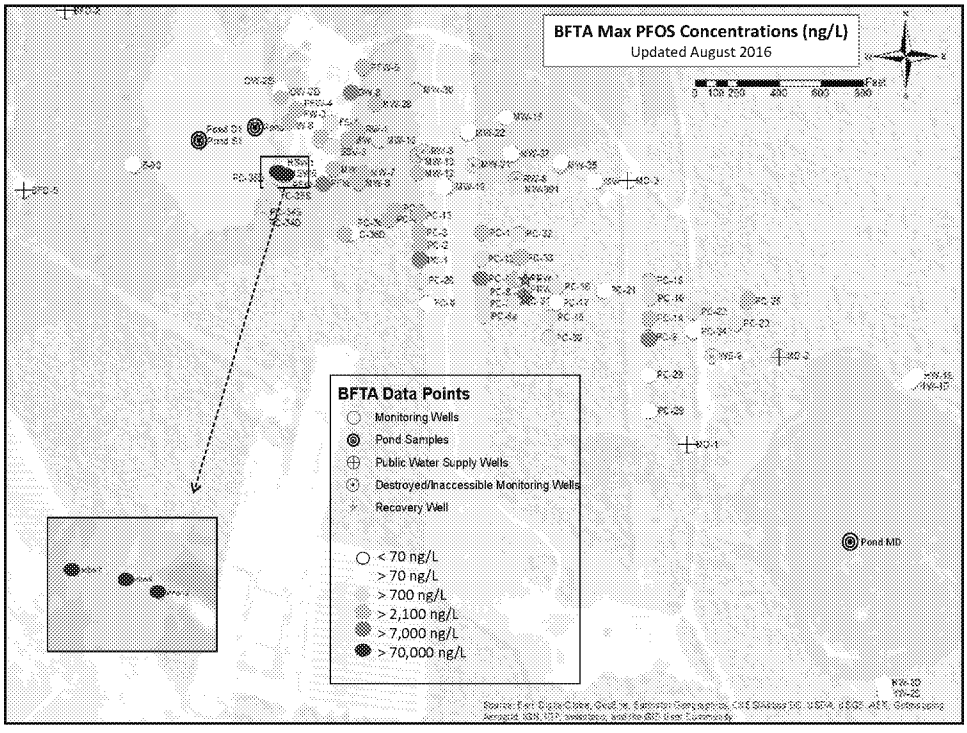
Hydrogeologic Cross Section
PFOS (ng/l)
July 2016


Barnstable Fire Training Academy
New Recovery Well
Perchlorate Plume in Groundwater (2 & 10 ppb contours)
Water Table Map (0.1 foot contour intervals asl)
October 2007
MC-3 supply well
MD-2 supply well

TCC 35


BFTA Max PFOS Concentrations (ng/L)
Updated August 2016
BFTA Data Points
Monitoring Wells
Pond Samples
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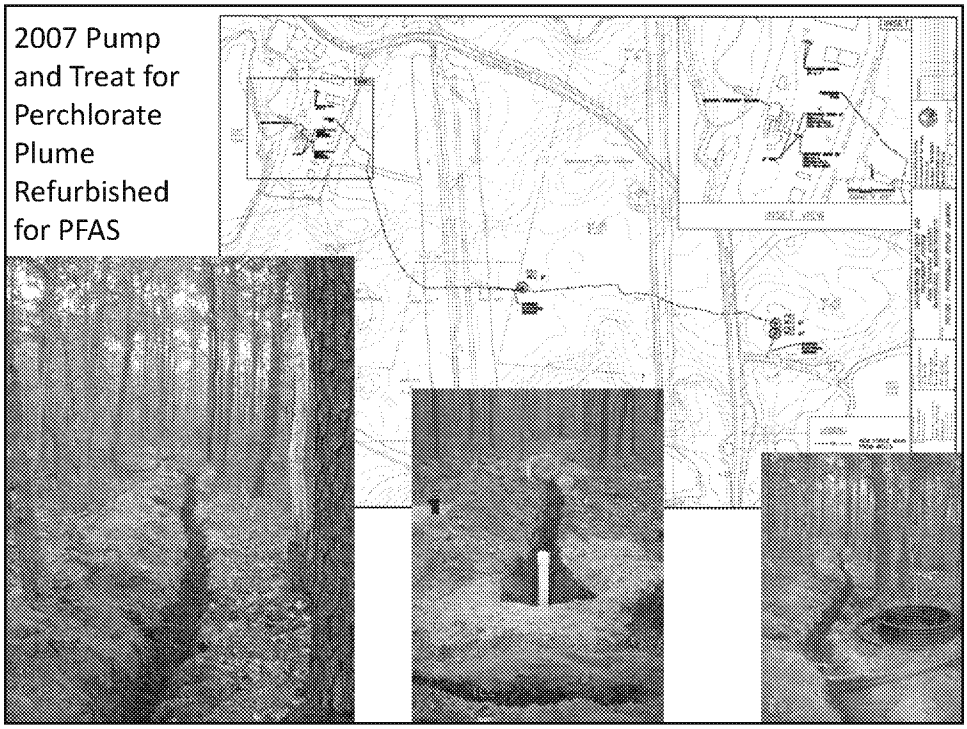
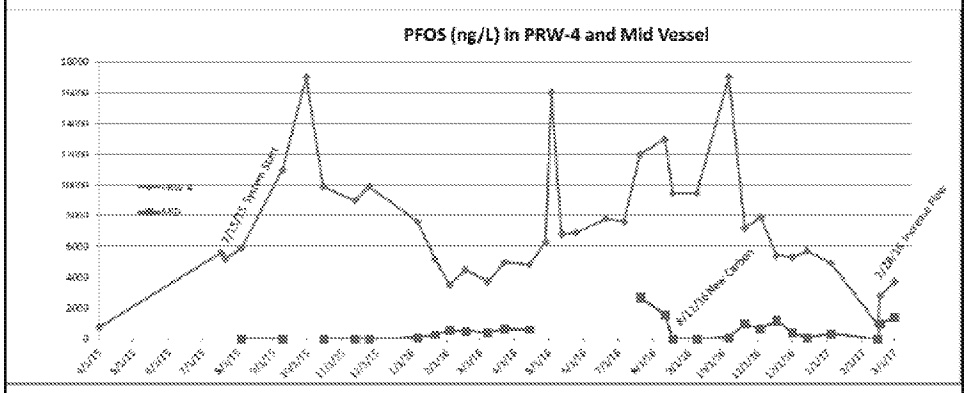
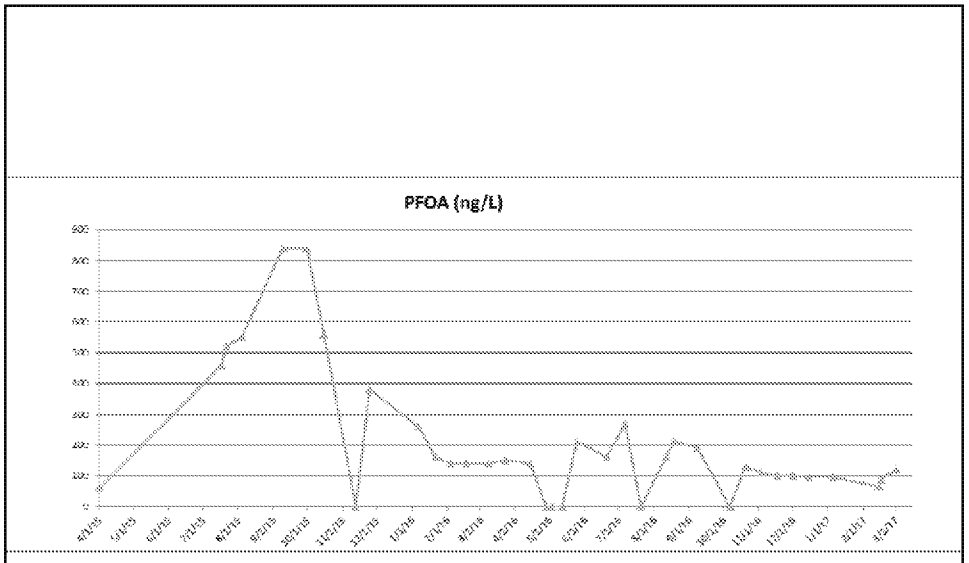
Recovery Well
< 70 ng/L
> 70 ng/L
> 700 ng/L
> 2,100 ng/L
> 7,000 ng/L
> 70,000 ng/L
Pond MD

2007 Pump and Treat for Perchlorate Plume Refurbished for PFAS



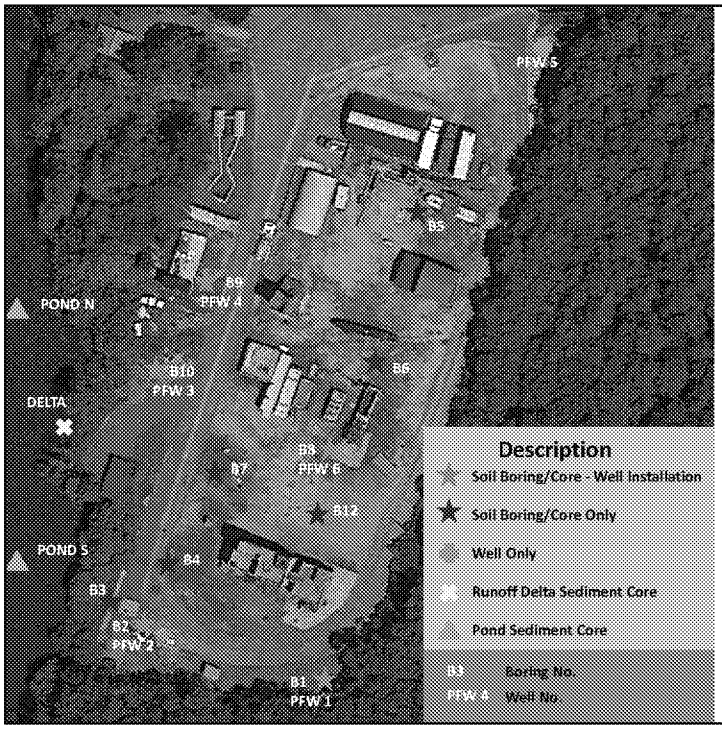

PFOS (ng/L) in PRW-4 and Mid Vessel
7/15/15 System Start
8/11/16 New Carbon
7/28/16 Restart Plant

4/21/2017

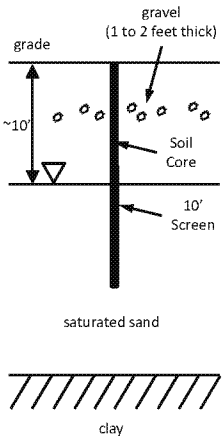

PFOA (ng/L)

Soil Investigation

March 2015

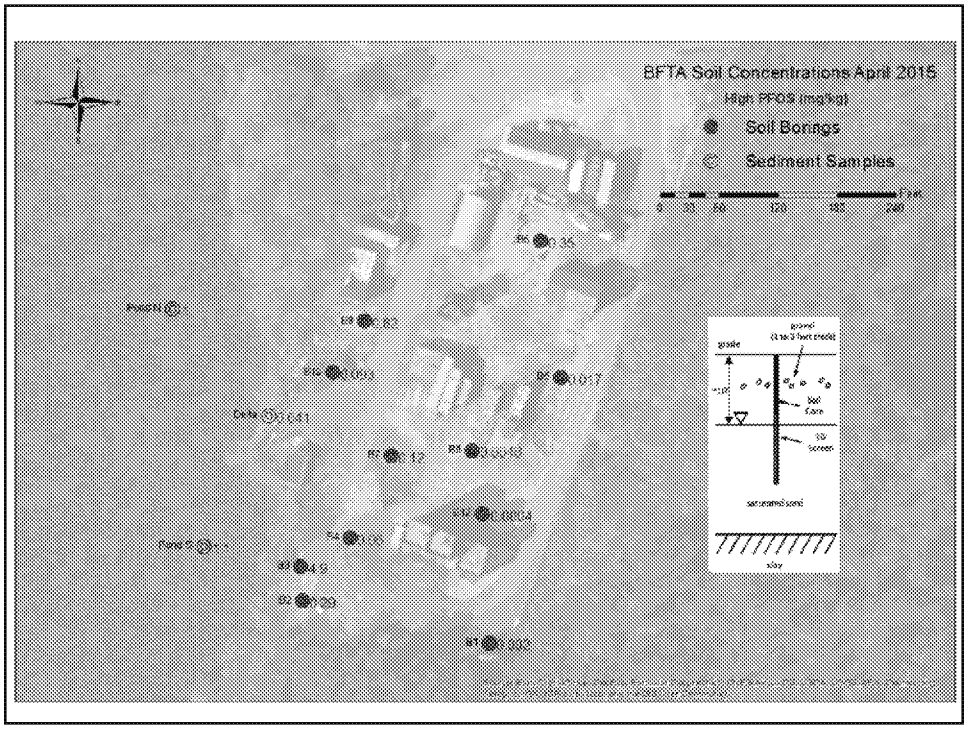


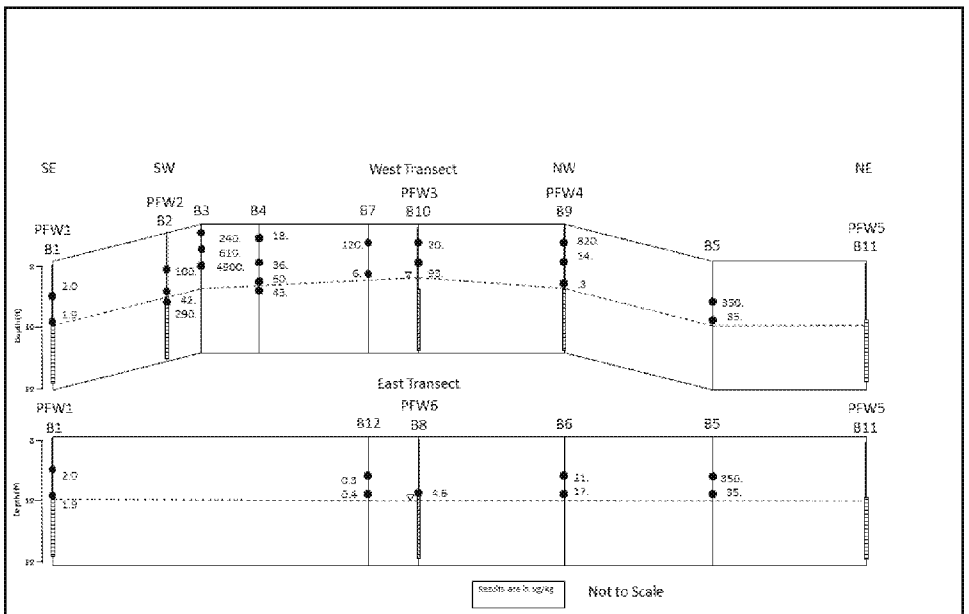
Final Boring Locations
April 2015
Soil Boring/Core



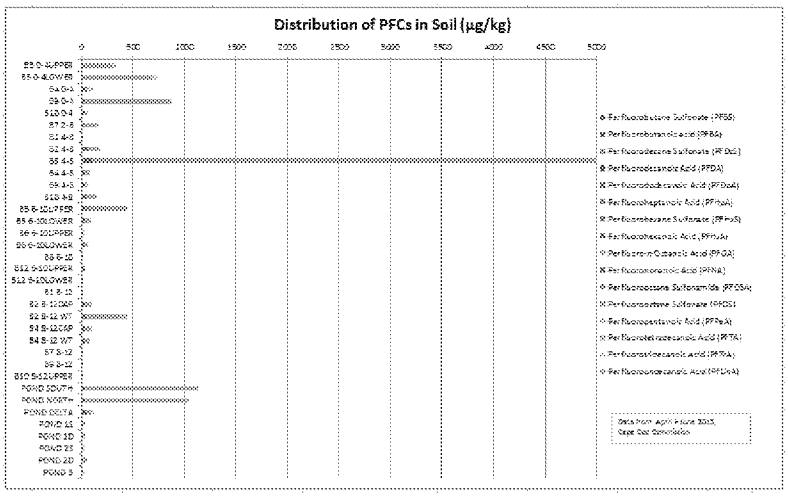
2007 Sparge

March 2015

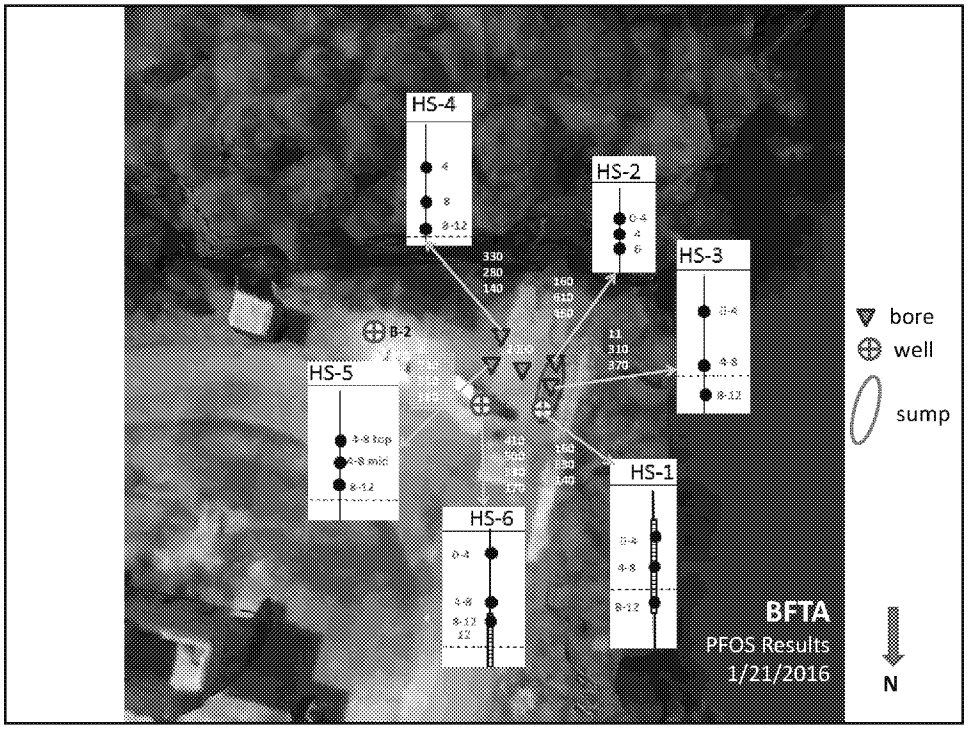

BFTA Soil Concentrations April 2015
High PFOS (mg/kg)
Soil Borings
Sediment Samples
0 30 60 120 180 240 Feet
B6 0.35
B8 0.3
B4 0.003
B5 0.017
Delta 0.041
B7 0.12
B9 0.0012
B3 0.0004
B1 0.332
gravel
(1 to 3 feet deep)
gravel
soil
core
soil
screen
sand and silt sand
clay


SE
SW
West Transect
NW
NE
PFW1
B1
PFW2
B2
B3
B4
B7
PFW3
B10
PFW4
B9
B5
PFW5
B11
2.0
1.9
100.
42.
290.
240.
610.
4500.
18.
36.
50.
43.
120.
6.
7.
30.
32.
820.
14.
3.
350.
35.
East Transect
PFW1
B1
B12
PFW6
B8
B6
B5
PFW5
B11
2.0
1.9
0.3
0.4
4.6
11.
17.
350.
35.
Results are in mg/kg
Not to Scale

2015 Soil Results



January 2016



OxyZone Bench Test

- EnChem Engineering Inc.
- Groundwater Treatment
- Obtained Groundwater Samples from Hot Spot
- Bench Test of OxyZone Performance

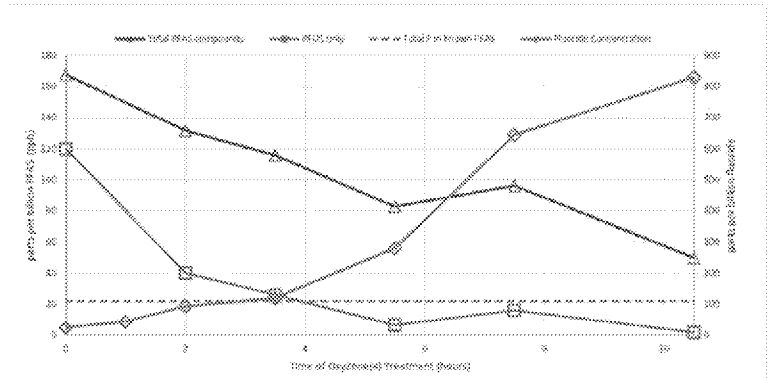


Figure 3: PFAS and Fluoride Treatment Results for PFW-2 Groundwater with Time

4/21/2017

Spring 2016

- Ready for action!
- Pump and Treat Operational
  - Performance review and upgrade Identified
- Soil Hot Spot identified
  - Evaluating Options
- Town has Downgradient Treatment on MD1 and MD2

May – July 2016
EPA New Health Advisory's
Exceedences of PFOS and 1-4 Dioxane in Hyannis System

MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

August 4, 2016

Barnstable County Commissioners
ATTN: Mr. Jack Yunits, County Administrator
3195 Main Street, Superior Courthouse
Barnstable, Massachusetts 02630

RE: **BARNSTABLE - HYANNIS**
Release Tracking Number (RTN) 4-0026179
Barnstable Fire/Rescue Training Academy
Off Mary Dunn Road
NOTICE OF RESPONSIBILITY/
REQUEST FOR IMMEDIATE RESPONSE
ACTION/INTERIM DEADLINE

This is an important notice.
Failure to take appropriate action in response
to this notice could result in serious legal consequences

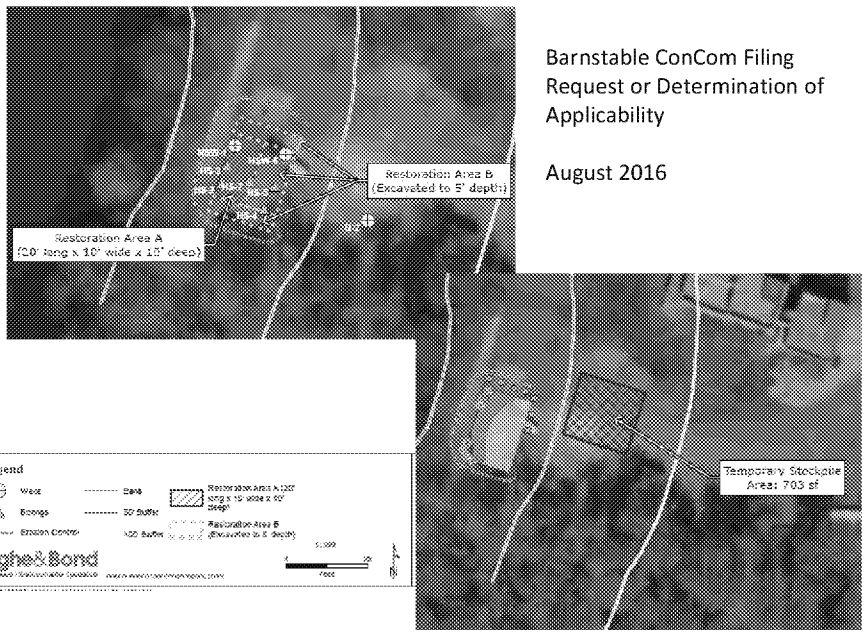
NOR Requires IRA for Assessment, Imminent Hazard, Water Supply Alternatives and specifically:

1)Hot Spot Soil Removal
2)Expanded or Increased Capture
3)Assess Imminent Hazards on Downgradient Public and Private Supplies

IRA Plan submitted on Sept 27, 2016

IRA Plan

- Full Assessment (Phase II)
- Imminent Hazard and SRM
- Alternative Water and Long Term Options
- Hot Spot Source Soil
- Hot Spot Groundwater Containment
- IRA Plan for Implementation
- Preliminary Comprehensive Actions
  (56 pages, 36 Figures, 6 Tables, Big Appendix)



Barnstable ConCom Filing
Request or Determination of
Applicability

August 2016

Hot Spot Source

- Soil Characterization for Removal and Disposal
  - Bourne
  - Taunton
  - New Hampshire

<u>Options</u>

Treat On-Site

Rembind

Pilot Innovative In-Situ Technologies

4/21/2017

RemBind Amendment

Soil Treatment Results

	PFOS* µg/L	PFOS % Reduction	PFOA* µg/L	PFOA % Reduction
Control	62.5	-	2.7	-
RemBind	0.39	99%	0.12	95%
RemBind Plus	<0.02	>99%	<0.02	>99%

*Australian Standard Leaching Protocol

January 2017

January 2017

January 2017

Hot Spot Concentrations

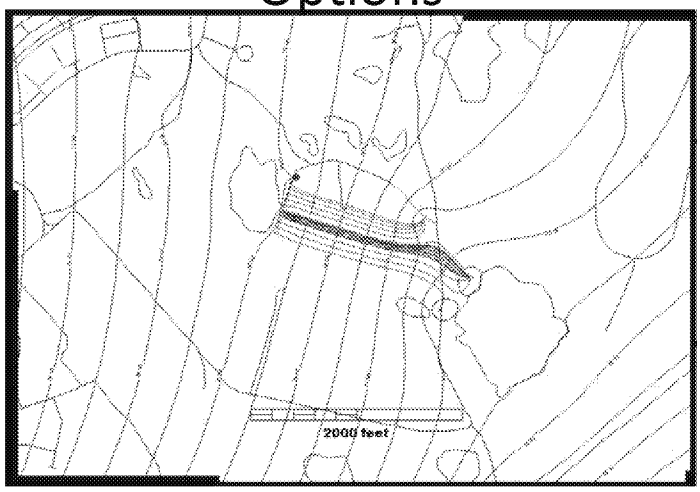
ID #	Date	Time	Description	ug/l PFOS	ug/l PFOA
1	25-Jan	10:00 AM	B3 Side Wall West	460	<1.2
	26-Jan	2:30 PM	B3 Side Wall West Treated	300	<1.2
2	25-Jan	11:00 AM	Soil Horizon Deep West	280	1.8
3	25-Jan	1:00 PM	H7 Side Wall	180	0.22
4	25-Jan	2:30 PM	NW Lift Bot (B3sidewall)	970	4.2

RemBind Treated Samples

Bottom of Hole Concentrations and Treatment

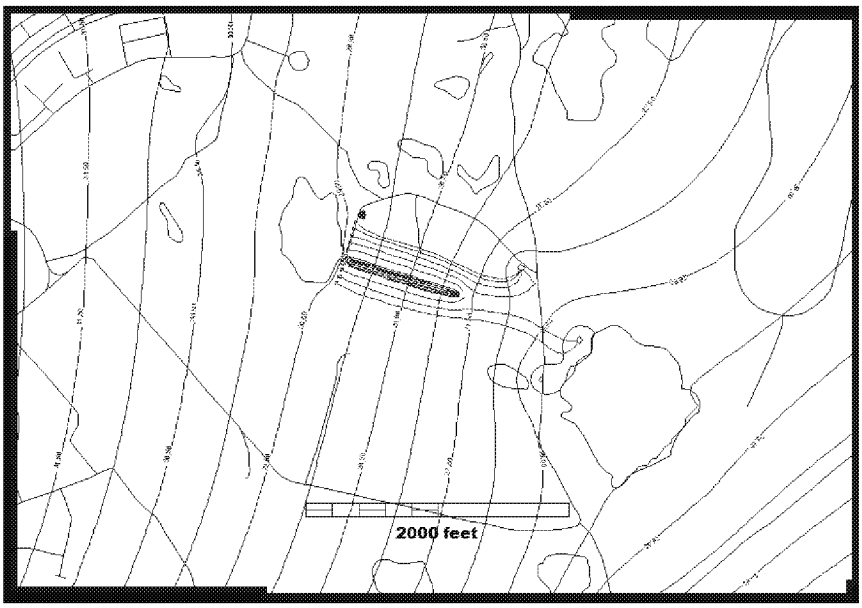
				ug/l	
ID #	**Date**	**Time**	**Description**	**PFOS**	**PFOA**
5	25-Jan	2:00 PM	Bot Hole 1	110	0.68
	26-Jan	2:00 PM	Bot Hole 1 Treated	56	<1.2
6	25-Jan	2:45 PM	Bot of 5 ft Lift	270	<1.2
	26-Jan	2:00 PM	Bot of 5 Lift Treated	45	<1.2
7	26-Jan	8:00 AM	Bot Hole 2	180	2.2
	26-Jan	8:00 AM	Bot Hole 2 Treated	32	<1.2

Hot Spot Plume Containment Options



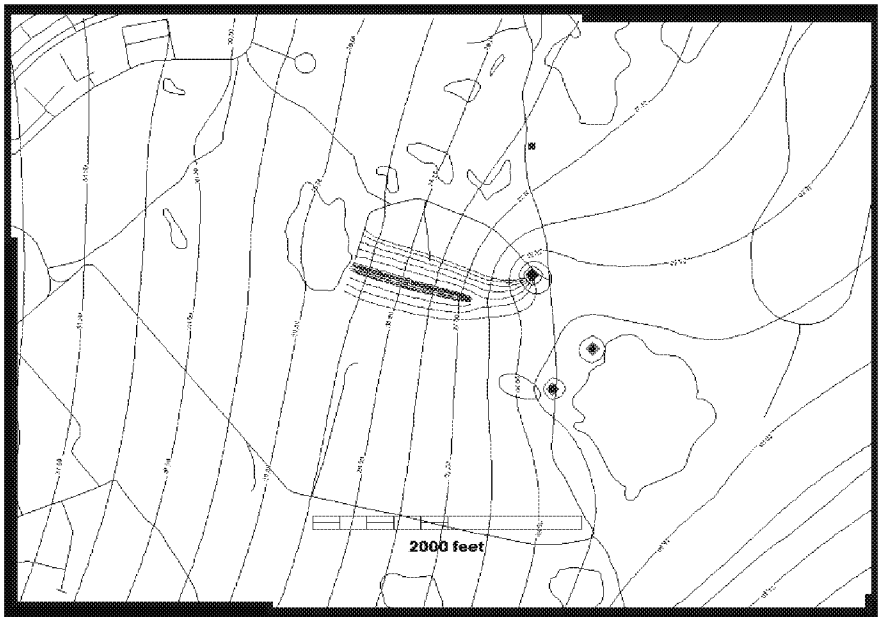
Average Pumping No Containment

Groundwater Modeling Figure- 66



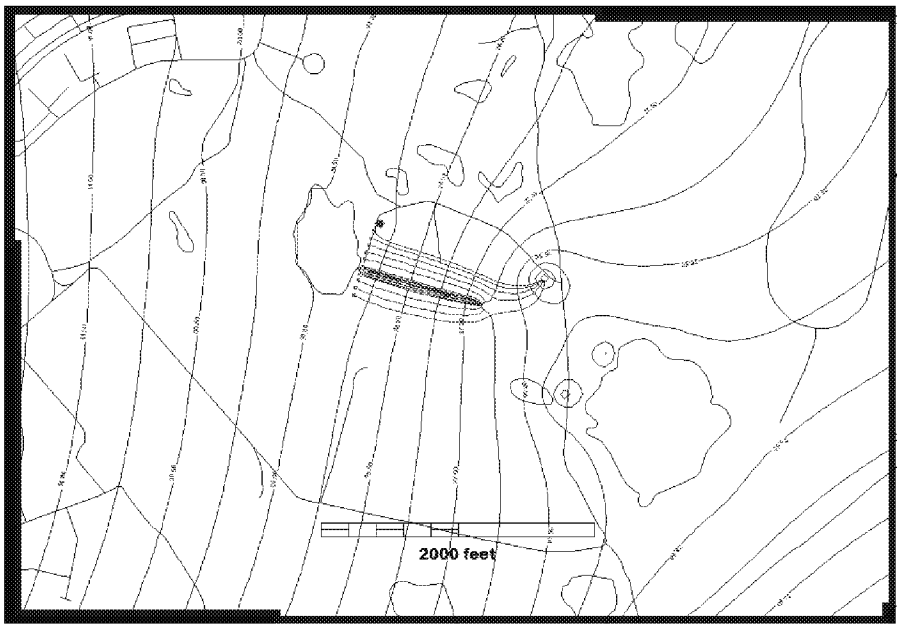
25 GPM Capture at Average Pumping Conditions

Groundwater Modeling Figure- 6.7



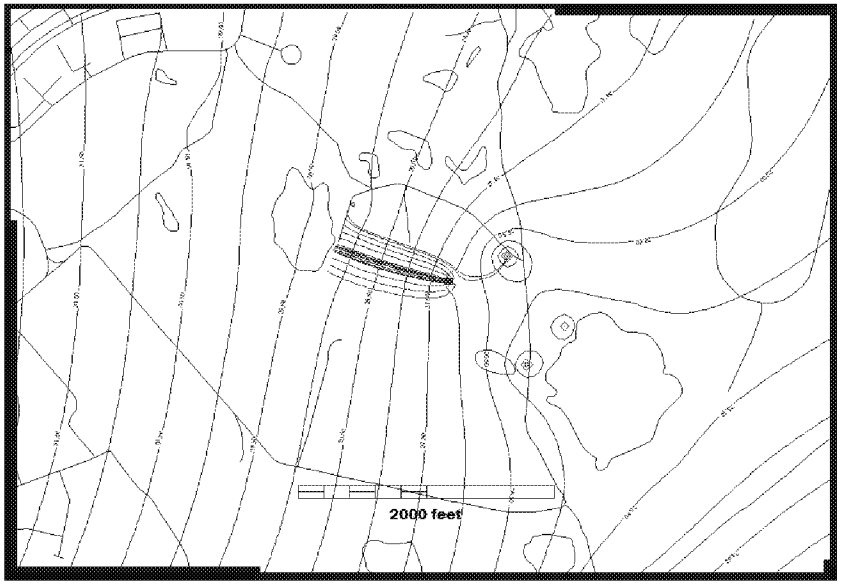
2015 Summer Pumping with 25 gpm capture

Groundwater Modeling Figure- 6.8



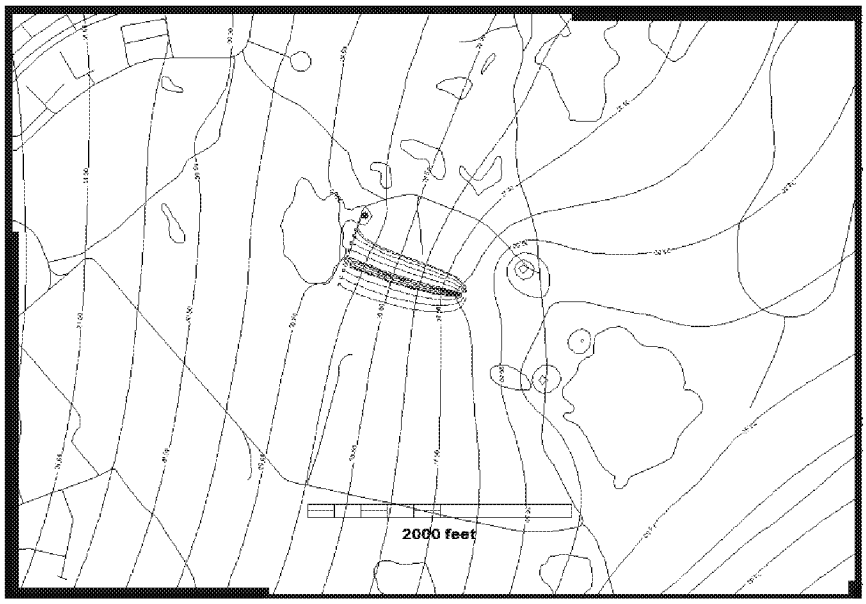
Summer 2016 pumping with capture at 40 gpm

Groundwater Modeling Figure- 69



Summer 2016 pumping with capture at 60 gpm

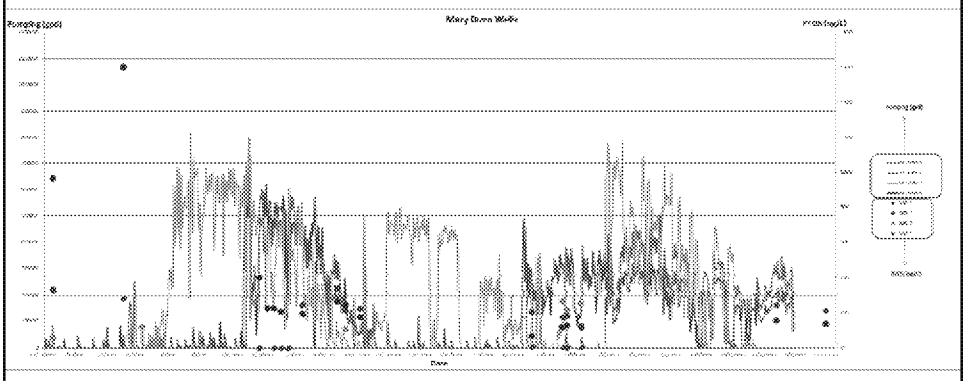
Groundwater Modeling Figure- 70

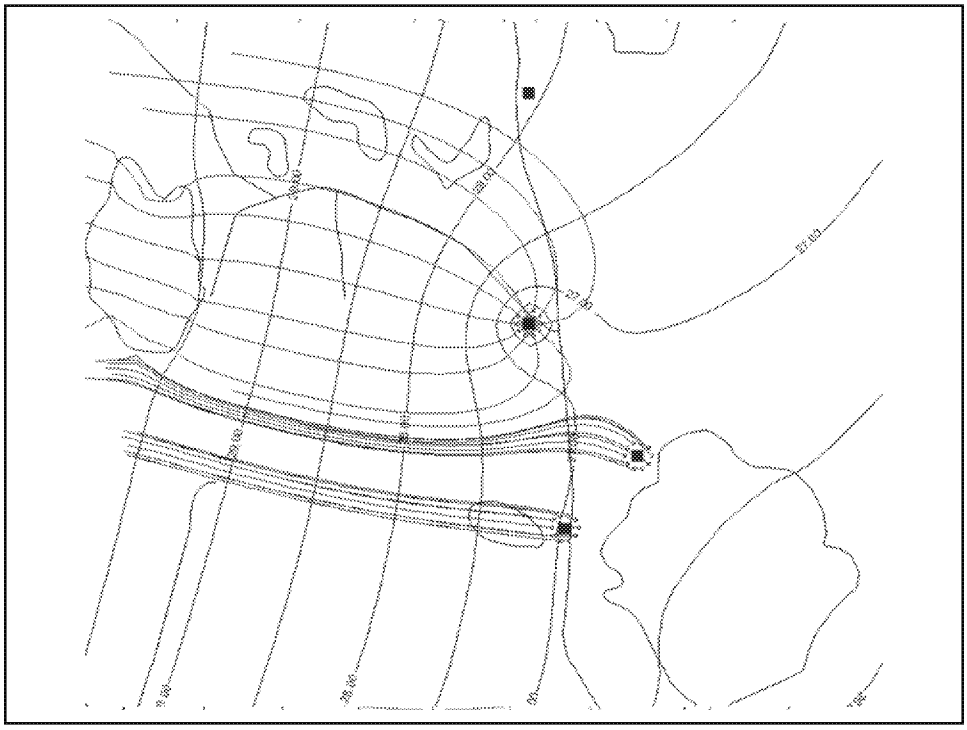


Summer 2016 pumping with capture at 80 gpm

Groundwater Modeling Figure- 71

Mary Dunn Well Field Treated Water





What is Clean-up Plan?

- Public Safety - Clean Drinking Water
- Coordination between Parties

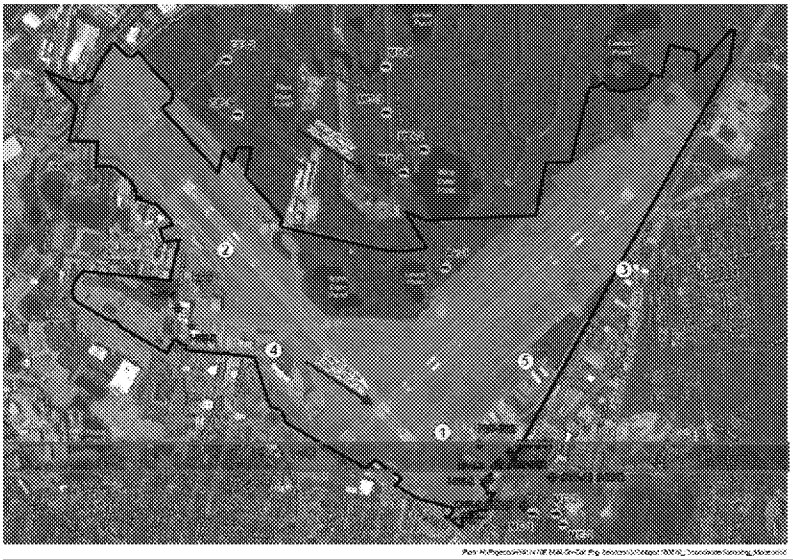
- Site Clean-up
  - Groundwater Containment/Treatment
  - Soil Removal/Treatment
  - Piloting of New Technologies
  - Treatment/Dredging of Pond

4/21/2017

Concluding Thoughts

- Be Pro-Active
- Tune-in to new types of contaminants and their sources
- Evaluate potential site activities
- Assess the potential presence
- Address Imminent Hazards
- Pursue Source Reduction

Other Cape Cod Occurrences of PFAS



1. ARFF/S/RE Building
2. 1991 Tri-Annual Drill location
3. 1981 Beech 18 aircraft accident location
4. 2016 Cirrus R22 aircraft accident location
5. AFFF Deployment Location

N

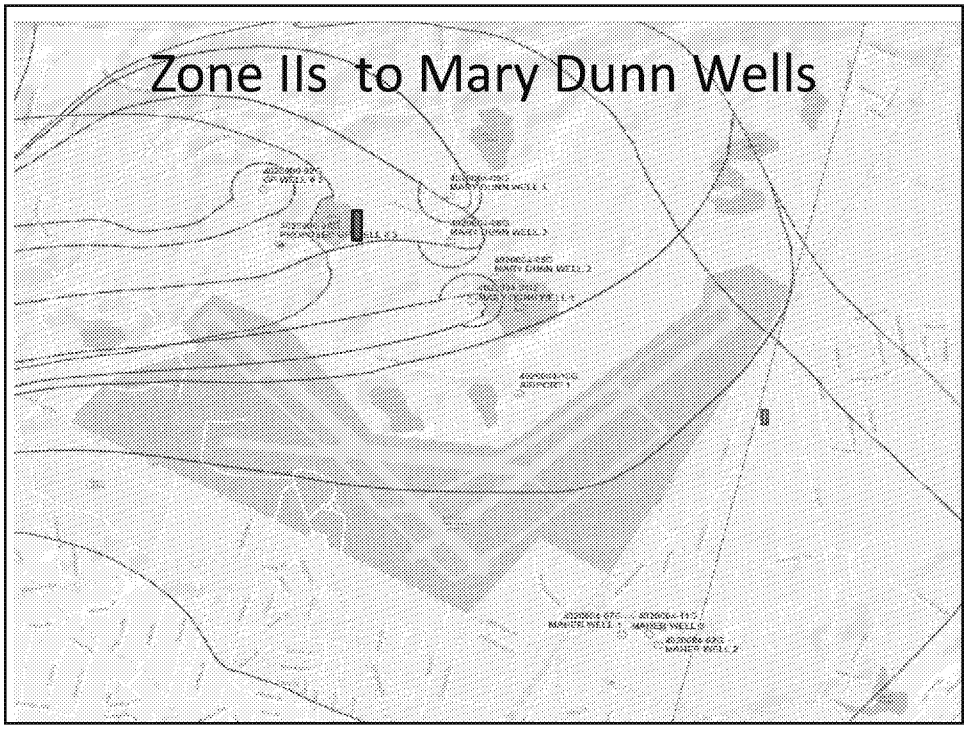
0 1,000

1" = 1,000 Feet

Horsley Witten Group

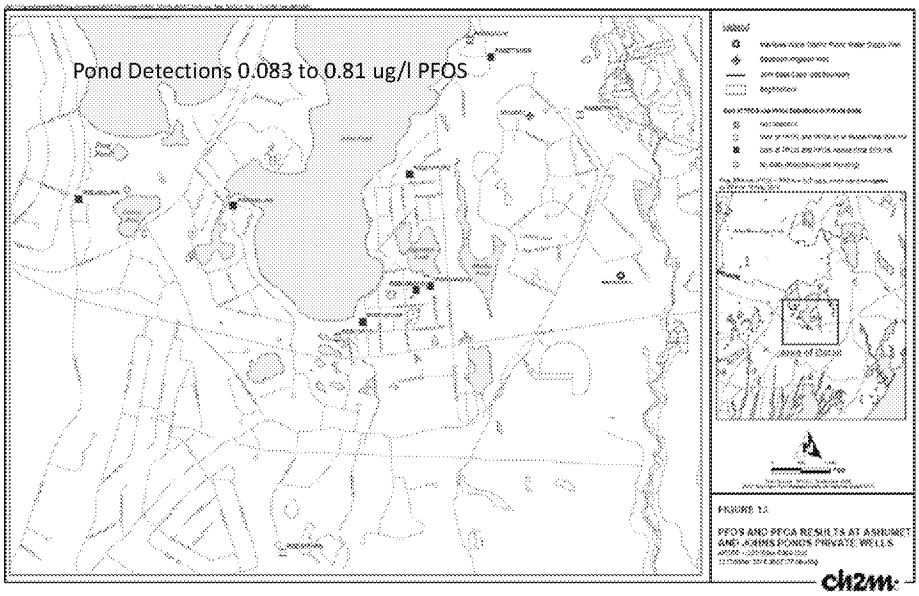
Barnstable Municipal Airport Hyannis, MA

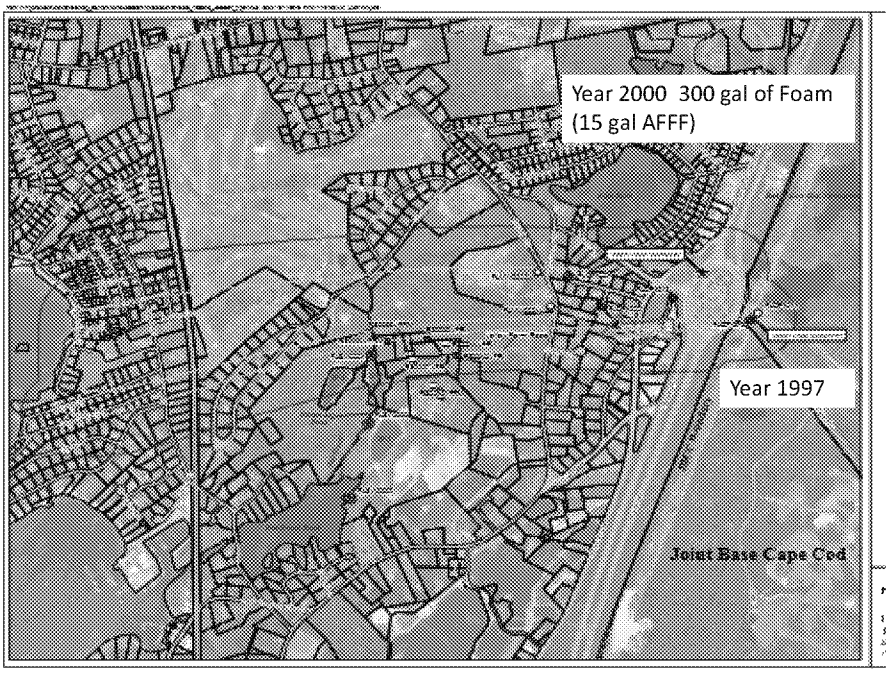
TCC 78


Zone IIs to Mary Dunn Wells

Cars were covered in fire suppression foam Monday morning at the Cumberland Farms on Route 132. David G. Curran photo.

Joint Base Cape Cod




Year 2000 300 gal of Foam
(15 gal AFFF)
Year 1997
Joint Base Cape Cod

The End