Welcome

Environmental Advisory Board Meeting

Robins Air Force Base

February 7, 2019

Welcome and Program Introduction

Dr. Linda Smyth
EAB Community Co-chair

Acronyms and Abbreviations

- AFB – Air Force Base
- AS – Air Sparging
- CAP – Corrective Action Plan
- CAPE – Cape Environmental Management Inc
- CB – Chlorobenzene
- COC – Contaminant of Concern
- D – Diluted
- EFR® – Enhanced Fluid Recovery
- GA EPD – Georgia Environmental Protection Division
- GWE – Groundwater Extraction

Acronyms and Abbreviations

- iSOC – In Situ Oxygen Curtain
- IW – Injection Well
- JP – Jet Propellant
- LNAPL – Light Non-Aqueous Phase Liquid
- M – Estimated Concentration
- MNA – Monitored Natural Attenuation
- µg/L – microgram(s) per liter
- ND – Non-detect
- PBR – Performance-Based Remediation
- RL – Remedial Level

Acronyms and Abbreviations

- SC – Site Closure
- SEAR – Surfactant Enhanced Aquifer Remediation
- SVE – Soil Vapor Extraction
- SVOC – Semi-Volatile Organic Compound
- SWMU – Solid Waste Management Unit
- TCE – Trichloroethene
- TMB – Trimethylbenzene
- VOC – Volatile Organic Compound

Environmental Advisory Board

Update on Progress at Select Restoration Sites

Meg Greenwald, P.E.

CAPE

February 7, 2019

Site Updates

- Solid Waste Management Unit (SWMU) 20 (OT020)
- SWMU 61
- SWMU 28 (CG028)

Environmental Advisory Board

SWMU 20
(OT020)
Update on Progress

Meg Greenwald
Principal Engineer
CAPE

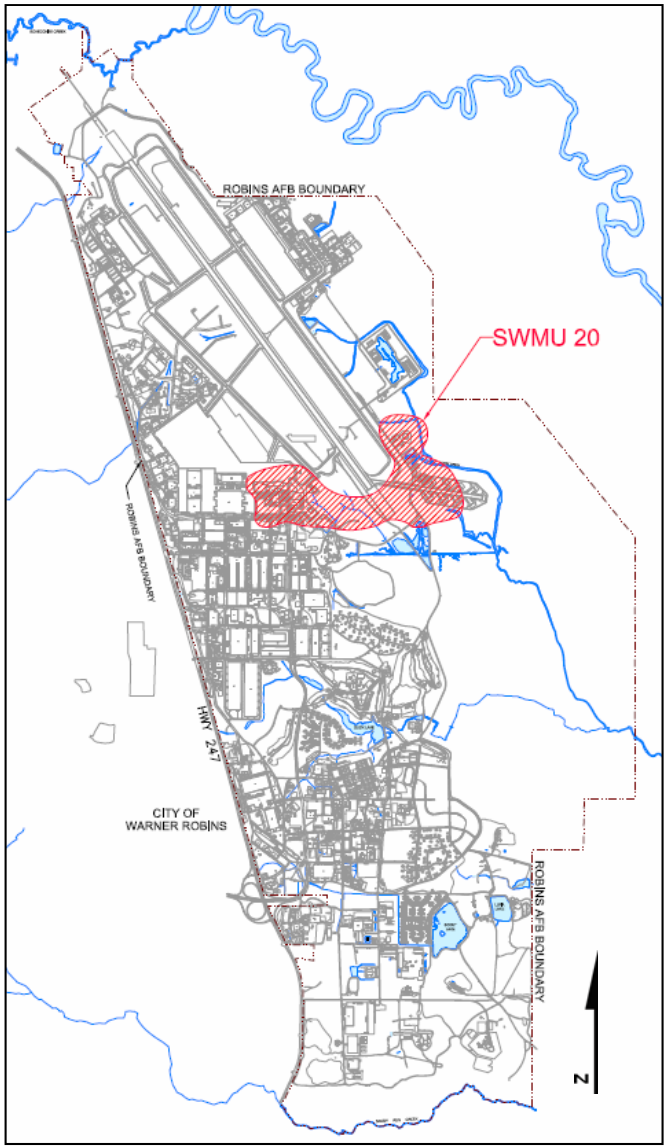
February 7, 2019

Overview

- Background
- Effectiveness of Pre-Performance-Based Remediation (PBR) Remedy
- Optimized remedy
- Expanded air sparging (AS)/soil vapor extraction (SVE) system and effectiveness
- Source area reductions: 2013, 2014, and 2018
- System performance to date
- Path forward

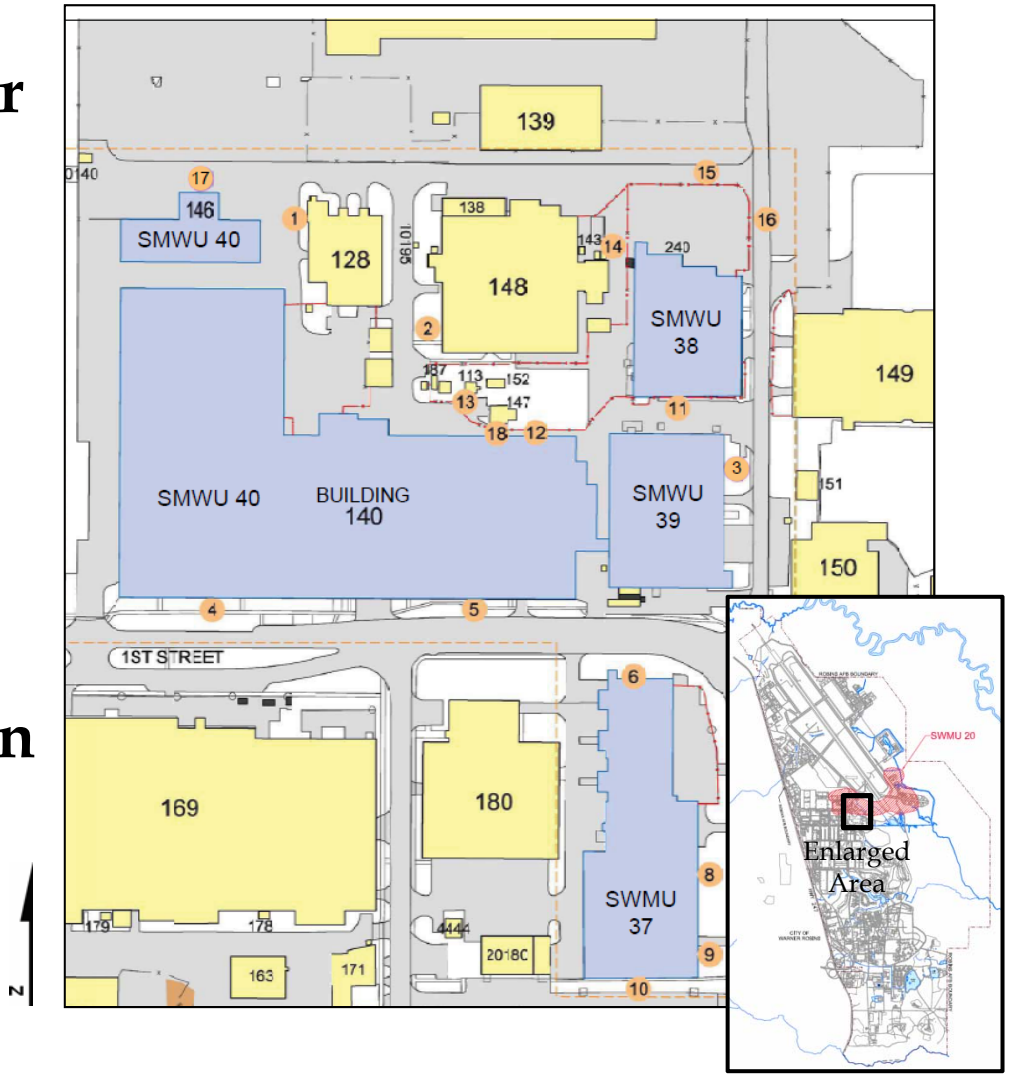
Background

- Groundwater contamination discovered in 1980s
- Consists primarily of chlorinated volatile organic compounds (VOCs), including:
  - Tetrachloroethene
  - Trichloroethene (TCE)
  - Dicholoroethene
  - Vinyl chloride
  - Chlorobenzene (CB)
  - Dichlorobenzenes



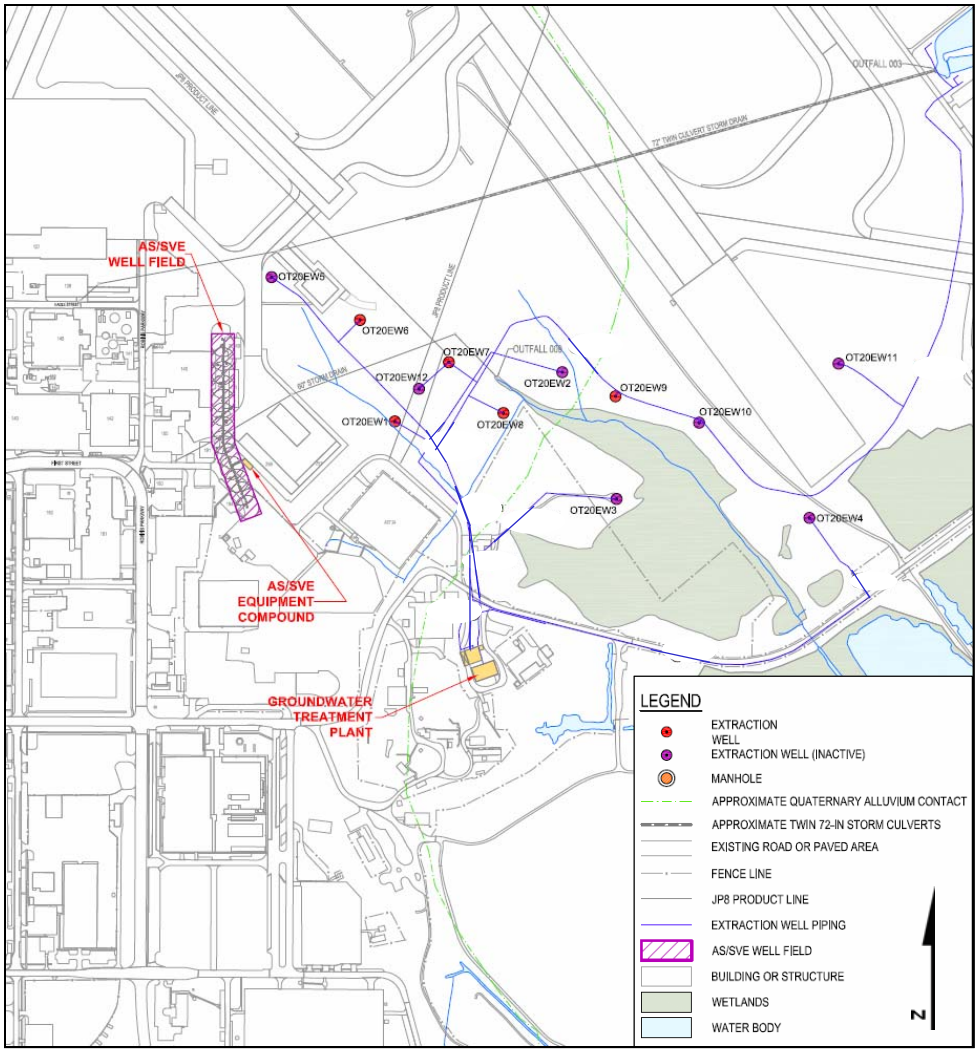
Background

- Multiple soil SWMUs contribute to groundwater plume (SWMUs 37, 38, 39 & 40)
- Groundwater contamination extends to maximum depth of approximately 100 feet below ground surface
- Original Corrective Action Plan (CAP) approved in 2002



Effectiveness of Pre-PBR Remedy

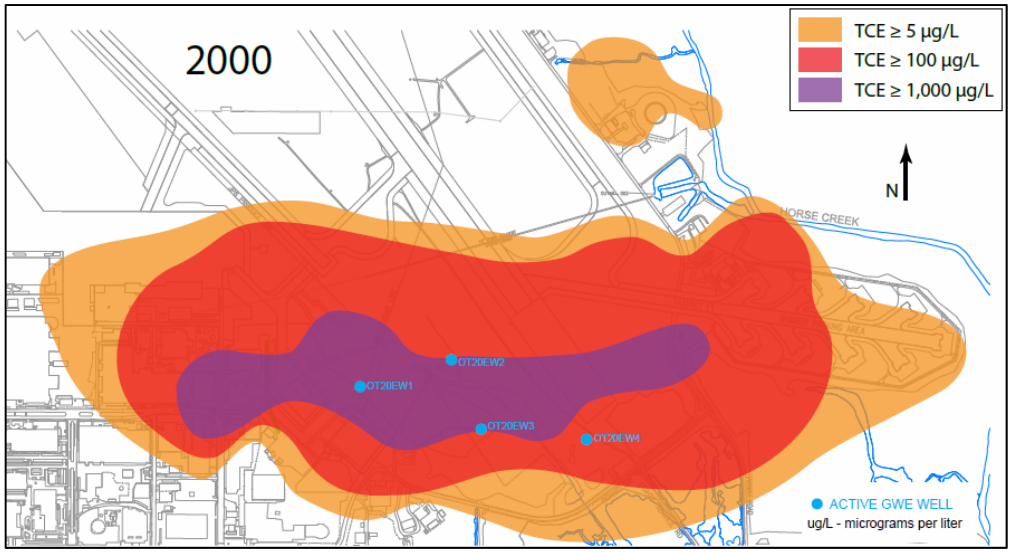
- AS/SVE curtain installed just downgradient of the source area
- Groundwater extraction (GWE) wells operating in downgradient portion of plume
- Network of approximately 60 monitoring wells

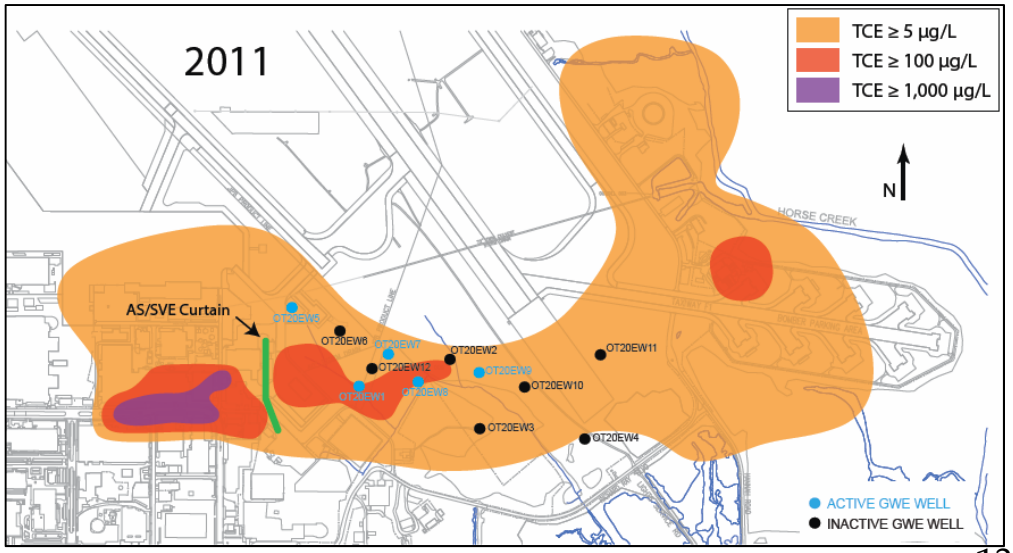


Pre-PBR Corrective Action System

Effectiveness of Pre-PBR Remedy

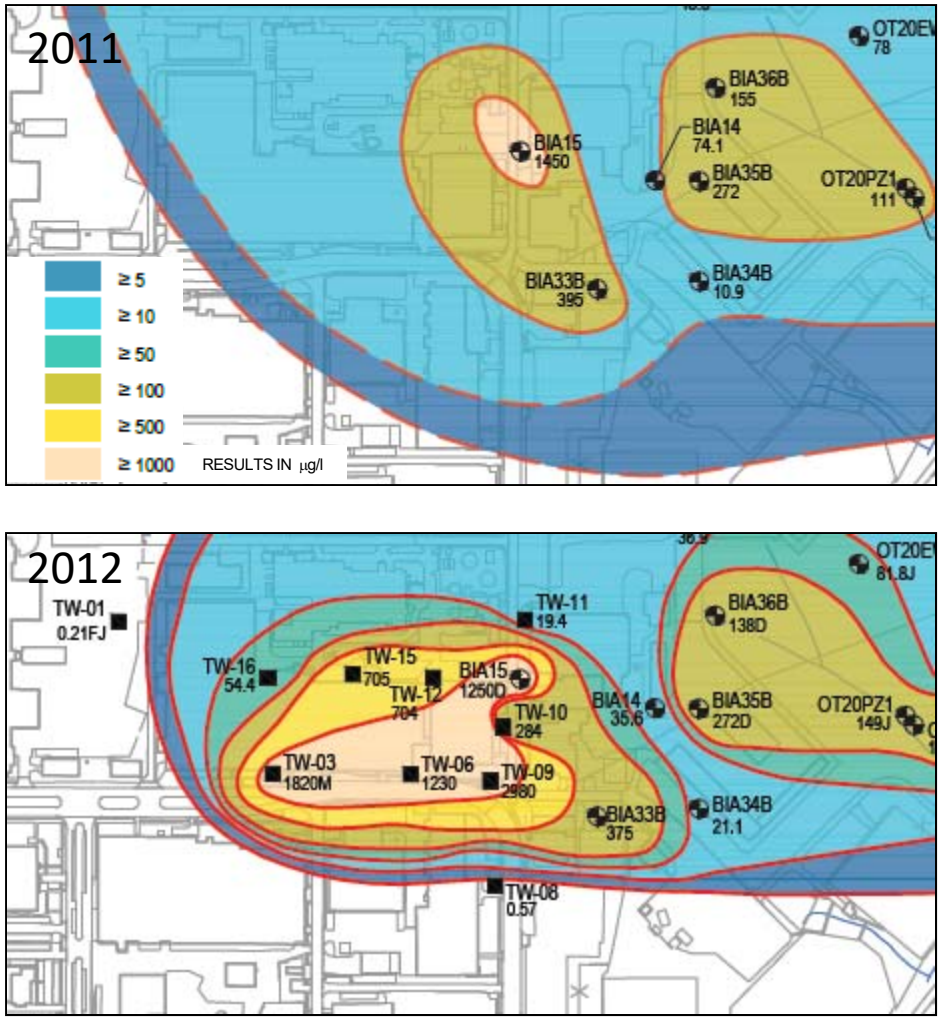
- AS/SVE curtain cut off contaminant migration from the source area
- GWE system decreased extent of downgradient the plume
- Natural attenuation limited migration at the edges of the plume, and aided in contaminant reduction in less concentrated portions of the plume





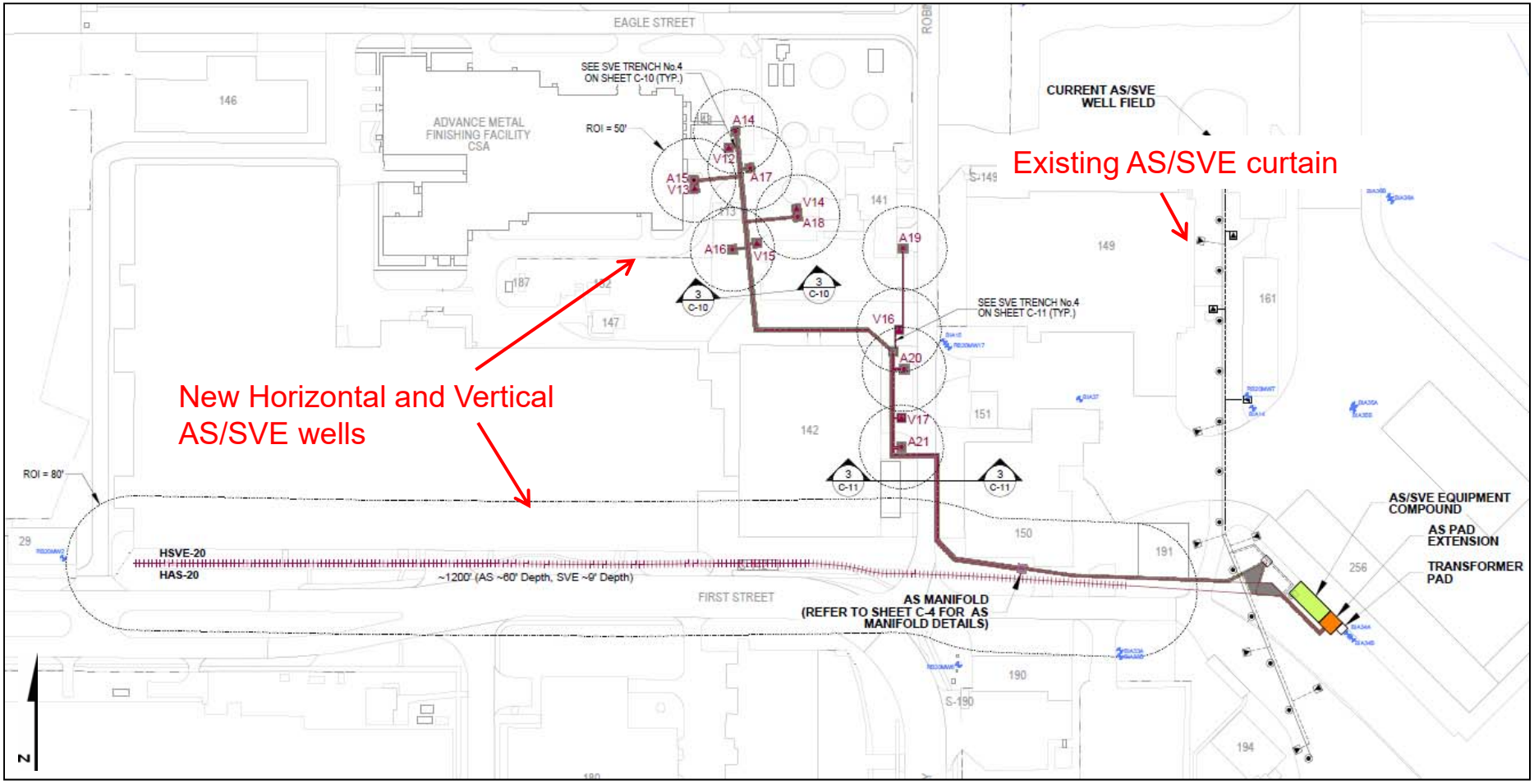
Optimized Remedy

- March 2012 – Conducted source area investigation to delineate highest concentrations
- October 2013 – Shut off GWE wells
- March 2014 – Began operation of horizontal and vertical AS/SVE wells to target more of source area

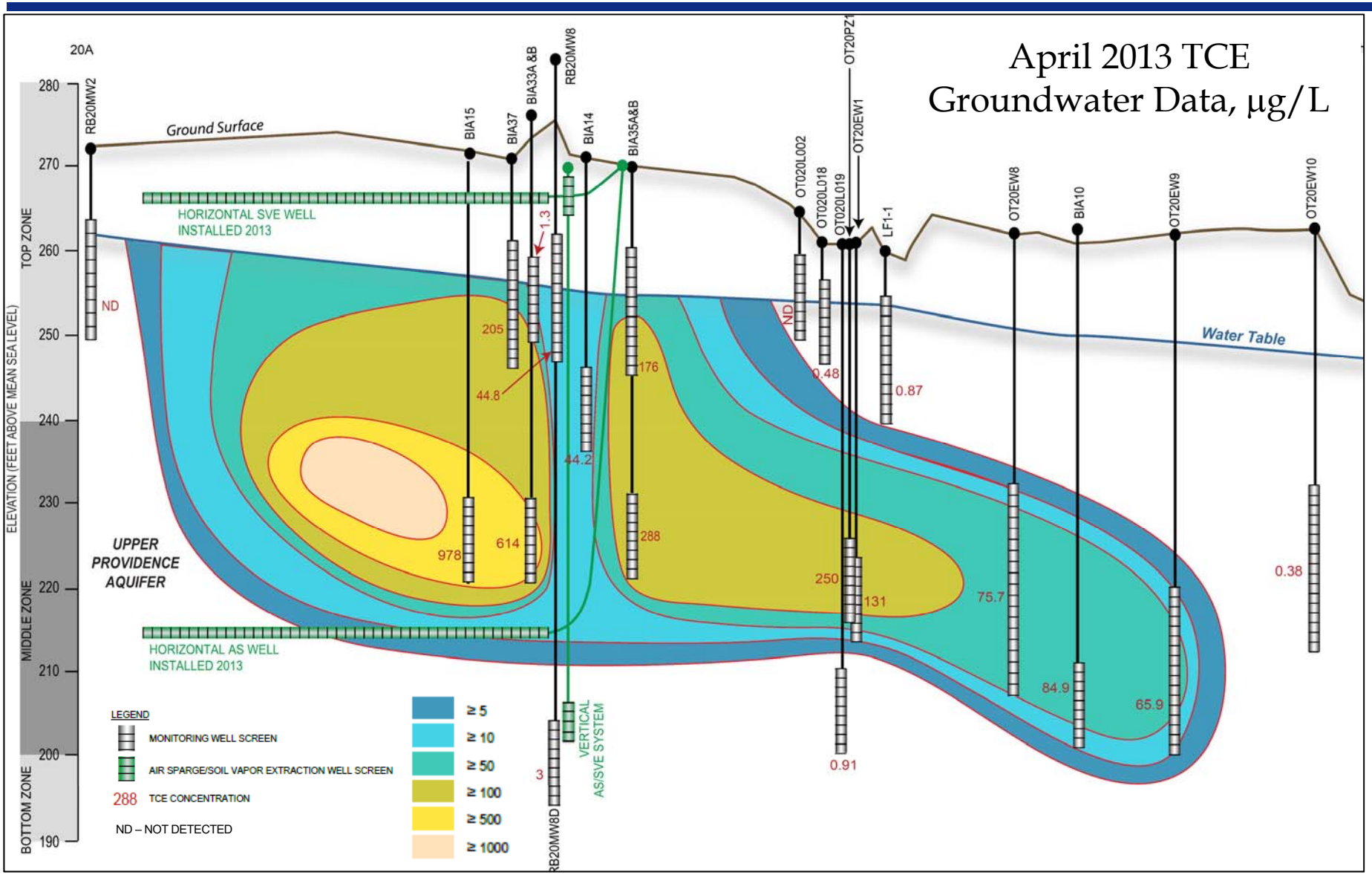


Delineation of TCE source area

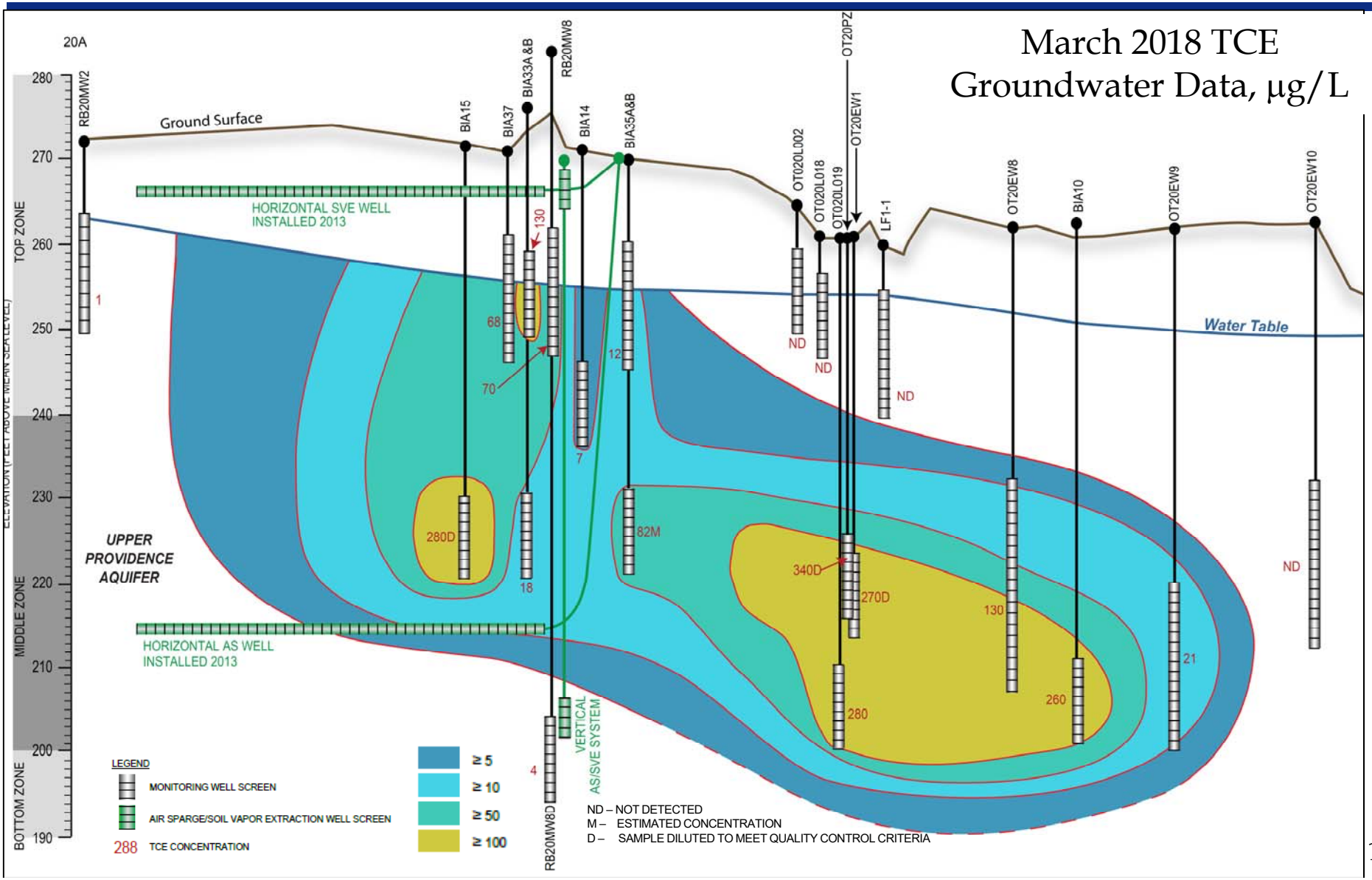
Expanded AS/SVE System and Effectiveness



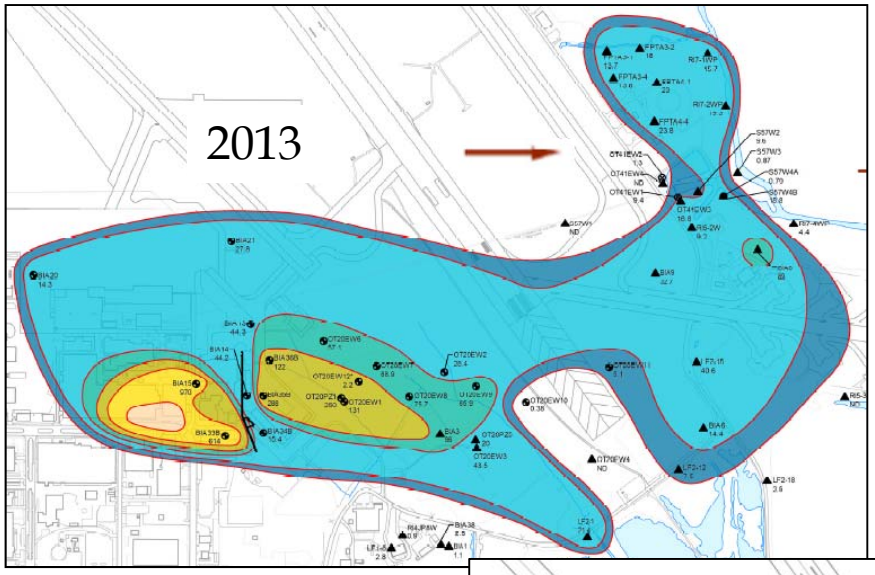
Expanded AS/SVE System and Effectiveness

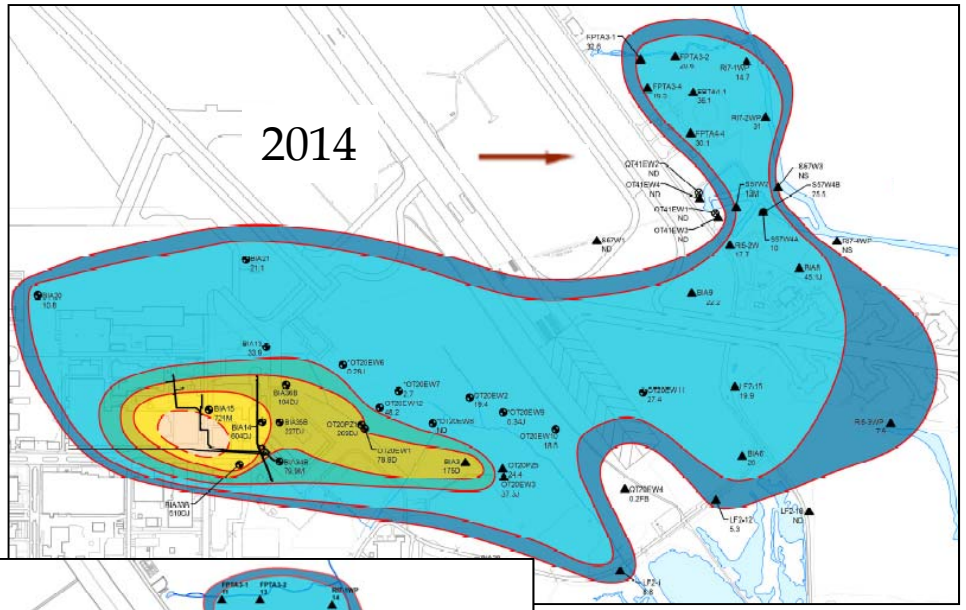


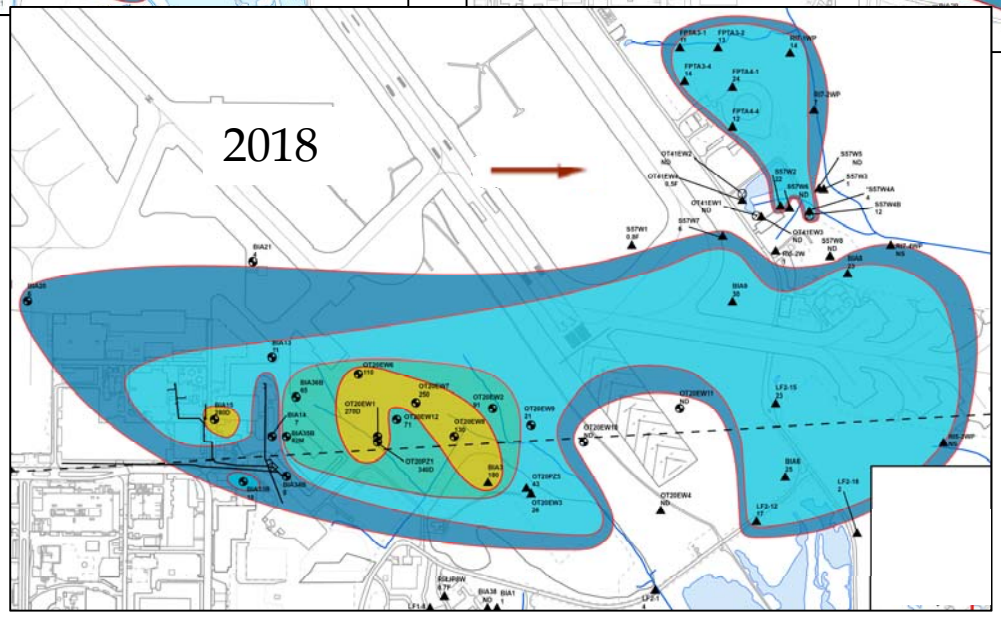
Expanded AS/SVE System and Effectiveness



Source Area Reductions: 2013, 2014, and 2018







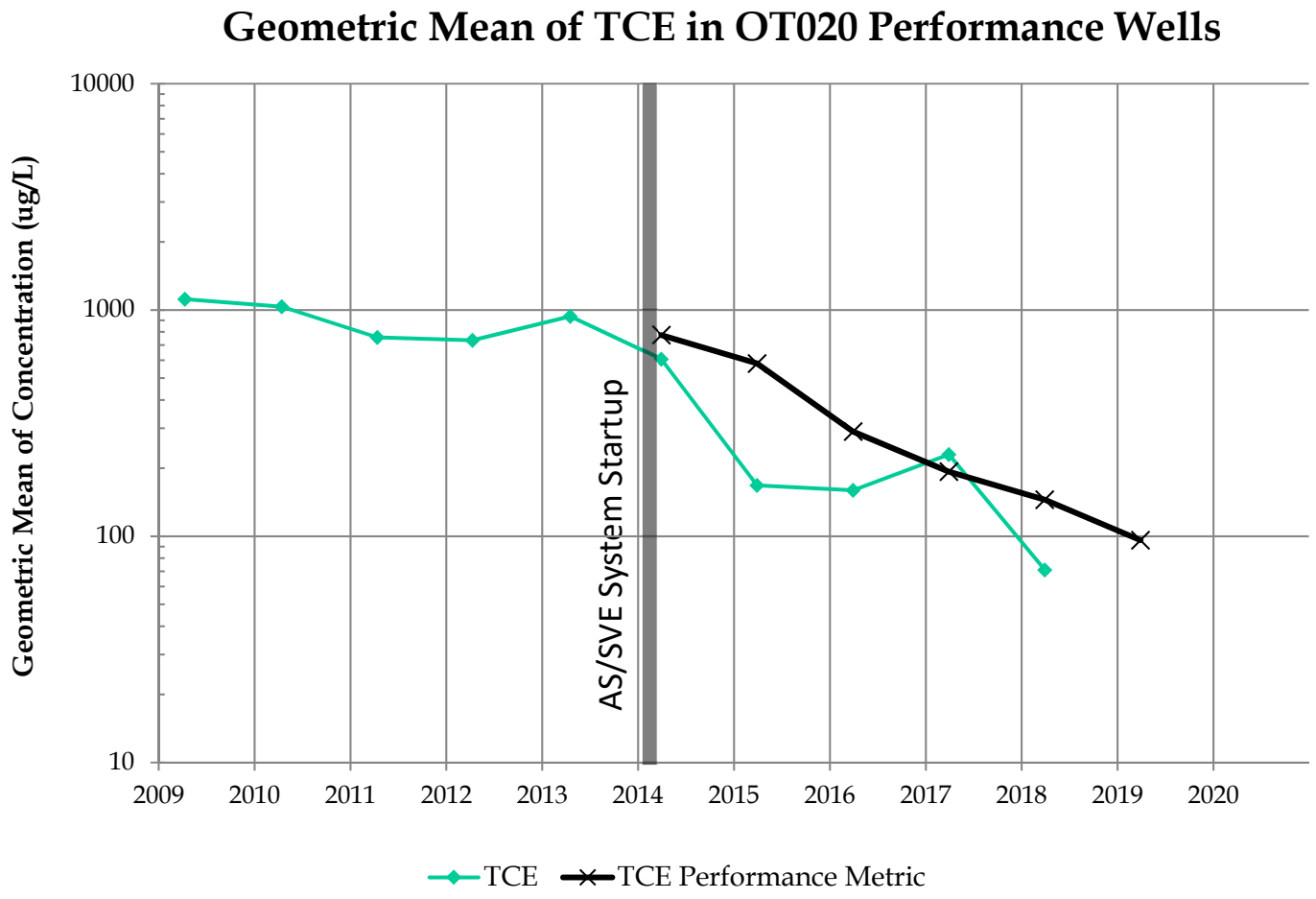
TCE
Concentration, µg/L

- ≥ 5
- ≥ 10
- ≥ 50
- ≥ 100
- ≥ 500
- ≥ 1000

Approximate Direction of Groundwater Flow

GRAPHIC SCALE
600' 300' 0 600'

System Performance to Date



Path Forward

- System Operation (2013 – 2019)
- Monitored Natural Attenuation (2020 – 2027)
- Confirmation Sampling (2027 – 2030)
- Site Closeout (2030)

Environmental Advisory Board

SWMU 61
Update on Progress

Meg Greenwald
Principal Engineer
CAPE

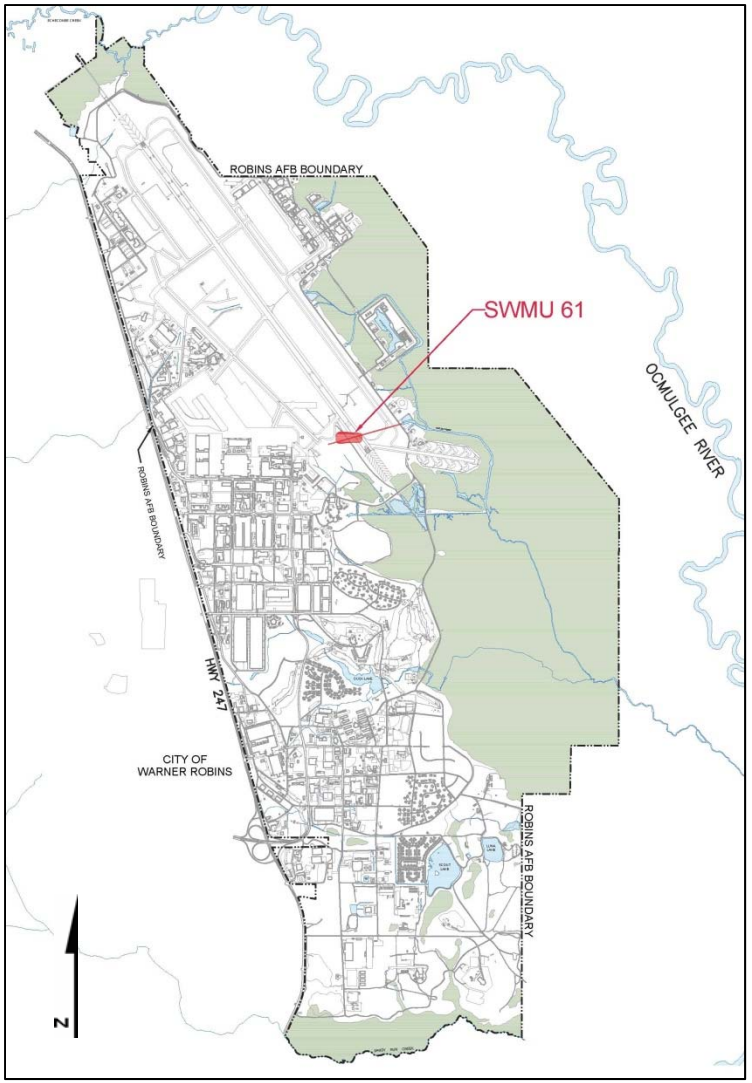
February 7, 2019

Overview

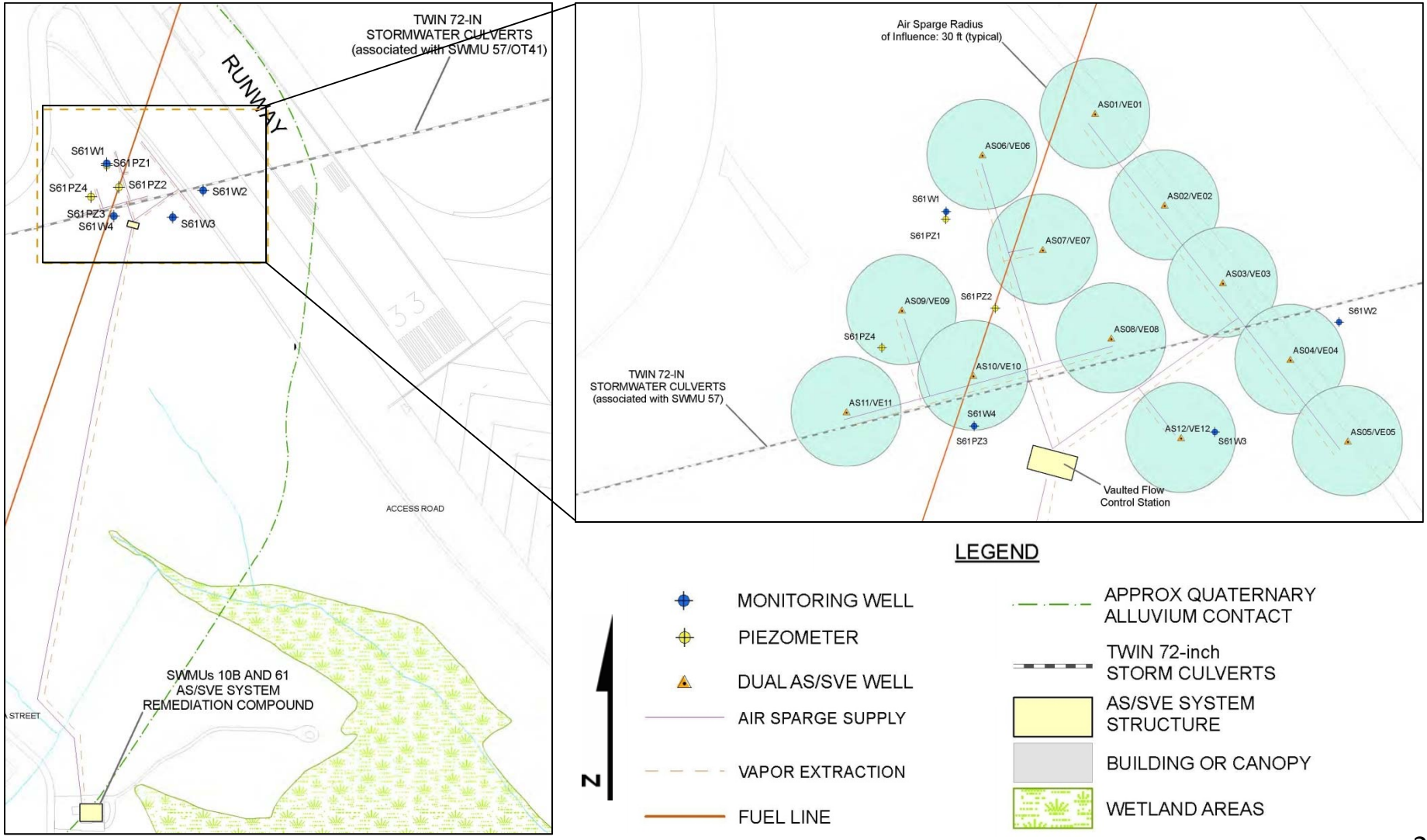
- Background
- Site layout
- Remedial action progress
- Path forward

Background

- **Jet Propellant (JP) fuel release from leaking valve on the JP Fuel No. 8 supply line**
- **Contaminants include:**
  - **VOCs**
    - Benzene
    - 1,3,5-Trimethylbenzene (TMB)
    - Ethylbenzene
  - **One Semi-volatile Organic Compound (SVOC)**
    - Naphthalene
- **Georgia Environmental Protection Division (GA EPD) approved the CAP in 2002**
  - **AS and SVE**
  - **Monitored natural attenuation (MNA)**



Site Layout


TWIN 72-IN
STORMWATER CULVERTS
(associated with SWMU 57/OT41)
RUNWAY
S61W1
S61PZ1
S61PZ4
S61PZ2
S61W2
S61PZ3
S61W4
S61W3
ACCESS ROAD
SWMUs 10B AND 61
AS/SVE SYSTEM
REMEDIATION COMPOUND
Air Sparge Radius
of Influence: 30 ft (typical)
AS01/VE01
AS06/VE06
AS02/VE02
S61W1
S61PZ1
AS07/VE07
AS03/VE03
AS09/VE09
S61PZ2
S61W2
S61PZ4
AS08/VE08
AS04/VE04
AS10/VE10
TWIN 72-IN
STORMWATER CULVERTS
(associated with SWMU 57)
AS11/VE11
S61W4
S61PZ3
AS12/VE12
S61W3
AS05/VE05
Vaulted Flow
Control Station
LEGEND
MONITORING WELL
PIEZOMETER
DUAL AS/SVE WELL
AIR SPARGE SUPPLY
VAPOR EXTRACTION
FUEL LINE
N
APPROX QUATERNARY
ALLUVIUM CONTACT
TWIN 72-inch
STORM CULVERTS
AS/SVE SYSTEM
STRUCTURE
BUILDING OR CANOPY
WETLAND AREAS

Remedial Action Progress

- Operated AS/SVE system from 2003 through 2009
  - Contaminant concentrations reduced to near Remedial Levels (RLs)
  - January 2009 – Ceased system operation and initiated MNA
  - By permit – Three year monitoring period required for site closure to assess rebound
- Closure monitoring sampling events
  - April 2009 – Annual sampling initiated
  - June 2011 – GA EPD approved monitoring in only S61W4

Remedial Action Progress

Annual monitoring results 2008 through 2013 at S61W4

Remedial Level	Date Sampled	4/23/2008	4/29/2009	4/29/2010	4/28/2011	4/16/2012	4/10/2013
µg/L	COCs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
5	Benzene	**6.44**	**6.41**	**6.35J**	**3.76J**	**5.6**	**5.7**
700	Ethylbenzene	**1.99J**	**4.96J**	**22.6J**	**10.7J**	**16.7**	**8.6**
12	1.3.5-Trimethylbenzene	**1.53J**	5U	**2.2J**	**4.22J**	**5.2**	**15.8**
6.5	Naphthalene	0.581U	0.505U	0.515U	**3.59**	0.086U	0.052U

Notes:

Remedial levels taken from Table 4-1, State-approved Draft Corrective Action Plan for SWMUs 57 and 61 dated June 2002.

µg/L = micrograms per liter

COC = Contaminant of Concern

Results in **BOLD** indicate detections

Highlighted results indicate a detection exceeding its respective remedial level

U = Result not detected. Numerical value preceding the "U" qualifier is the reporting limit.

J = Analyte is detected. The reported result is an estimated value.

Remedial Action Progress

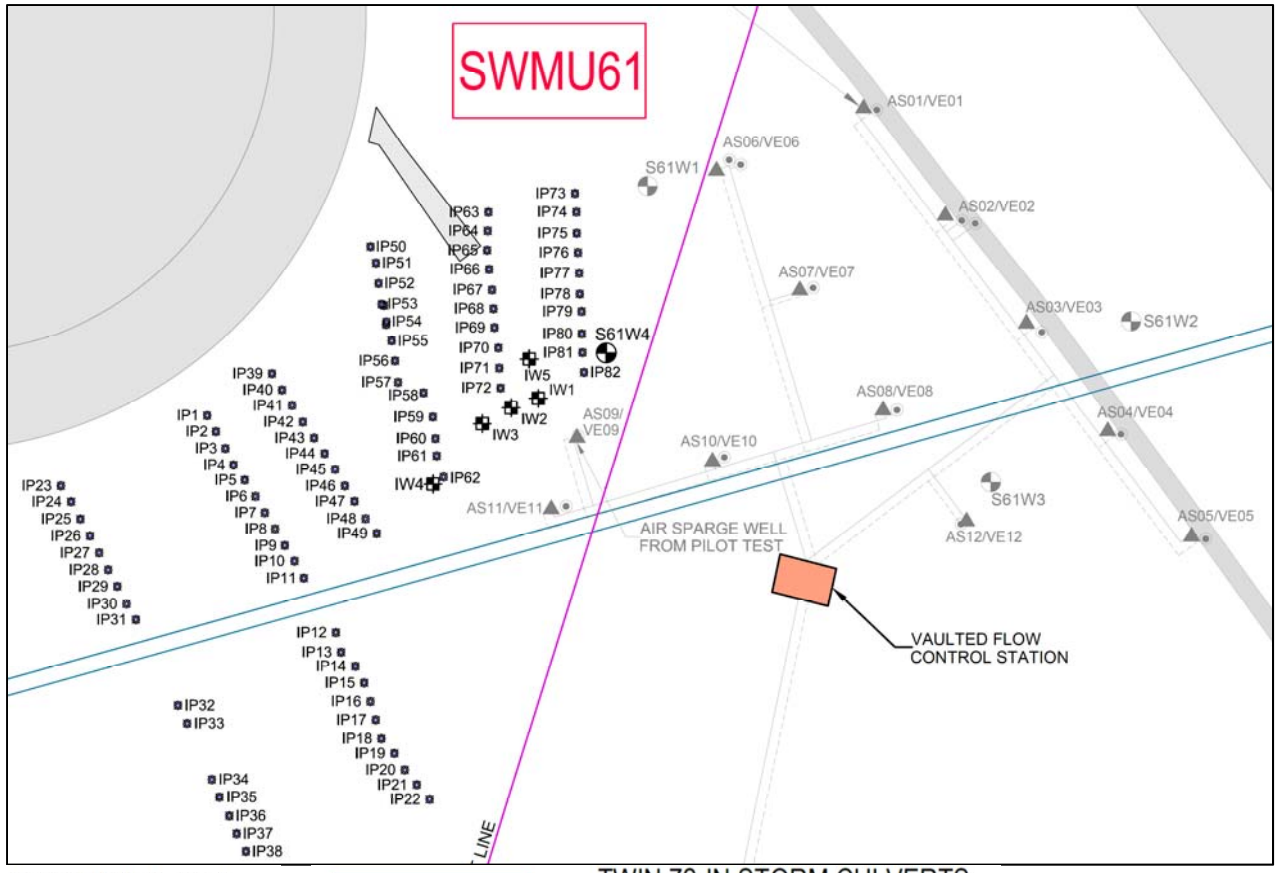
- **Benzene remained near the RL: concentrations fluctuating both above and below RL**
- **TMB detected above RL in April 2013**
  - **Prompted initial concern from GA EPD**
- **Ethylbenzene and naphthalene remained below RL through April 2013**

Remedial Action Progress

- **Reviewed recalcitrant benzene and TMB detection with GA EPD in October 2013**
  - **Began quarterly monitoring**
  - **Collaborated on idea to perform polishing using In-Situ Oxygen Curtain (iSOC™) and an oxygen releasing compound injection called TersOX™**
  - **Implemented iSOC™ December 2013**
  - **Installed TersOX™ January 2014**

Remedial Action Progress

iSOC™ and TersOX™ Injection Locations



Remedial Action Progress

Monitoring results October 2013 through October 2014 at S61W4

Began iSOC™ → Began TersOX™

Remedial Level	Date Sampled	10/1/2013	1/2/2014	3/20/2014	4/12/2014	7/14/2014	10/22/2014
µg/L	COCs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
5	Benzene	**5.60**	**4.6**	0.34U	**5.5**	**5.4**	**4.4**
700	Ethylbenzene	**69.7**	**48.6**	**0.4J**	**65.3J**	**65**	**100**
12	1.3.5-Trimethylbenzene	**13.4**	**3.2**	**1.1**	**10.0**	**11.0**	**6.6**
6.5	Naphthalene	**15.6**	**2.0**	**4.6J**	**7.6J**	**15.1**	**27.1**

Notes:

Remedial levels taken from Table 4-1, State-approved Draft Corrective Action Plan for SWMUs 57 and 61 dated June 2002.

µg/L = micrograms per liter

Results in **BOLD** indicate detections

Highlighted results indicate a detection exceeding its respective remedial level

U = Result not detected. Numerical value preceding the "U" qualifier is the reporting limit.

J = Analyte is detected. The reported result is an estimated value.

Remedial Action Progress

- **Since transitioning back to MNA, COC concentrations at S61W4 have remained fairly consistent**

Resume MNA

Remedial Level	Date Sampled	10/22/2014	4/22/2015	3/22/2016	11/10/2016	3/9/2017	3/23/2018	8/1/2018
µg/L	COCs	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
5	Benzene	**4.4**	**4.8**	**5 M**	**4.1**	**5**	**4**	**5**
700	Ethylbenzene	**100 D**	**67.8 M**	**42**	NA	**48 M**	**53**	**52**
12	1.3.5-Trimethylbenzene	**6.6**	**6**	**3 J**	**2.3**	2 U	2 U	2 U
6.5	Naphthalene	**27.1**	**14.6 DM**	**15**	**23 J**	**18 J**	**14**	**18**

Notes:

Remedial levels taken from Table 4-1, State-approved Draft Corrective Action Plan for SWMUs 57 and 61 dated June 2002.

µg/L = micrograms per liter

Results in **BOLD** indicate detections

Highlighted results indicate a detection exceeding its respective remedial level

U = Result not detected. Numerical value preceding the "U" qualifier is the reporting limit.

J = Analyte is detected. The reported result is an estimated value.

D = The result is from a diluted analysis

M = Detected, a matrix effect was present. Results should be considered estimated.

NA = Not Analyzed

Remedial Action Progress

- In April 2018, CAPE proposed to conduct dilute hydrogen peroxide and potable water injections to stimulate biological processes
- Dilute hydrogen peroxide injections were conducted in June and August 2018 using existing injection wells (IWs) (IW-1 through IW-5)

Remedial Action Progress

- Field measurements for dissolved oxygen indicated increases in oxygen concentrations
- August 2018 data indicated that naphthalene concentrations have not yet been impacted by hydrogen peroxide injections
- CAPE installed new oxygen diffusers to replace iSOCs™ and started them in December 2018
- Oxygen diffusers will allow oxygen to continually diffuse into groundwater for approximately three months prior to annual sampling in March 2019

Path Forward

- Operate oxygen diffusers to address naphthalene concentrations
- Once contamination is below RLs, re-initiate closure monitoring
- After three years of successful closure monitoring, request SC

Environmental Advisory Board

SWMU 28
(CG-028)
Update on Progress

Meg Greenwald
Principal Engineer
CAPE

February 7, 2019

Overview

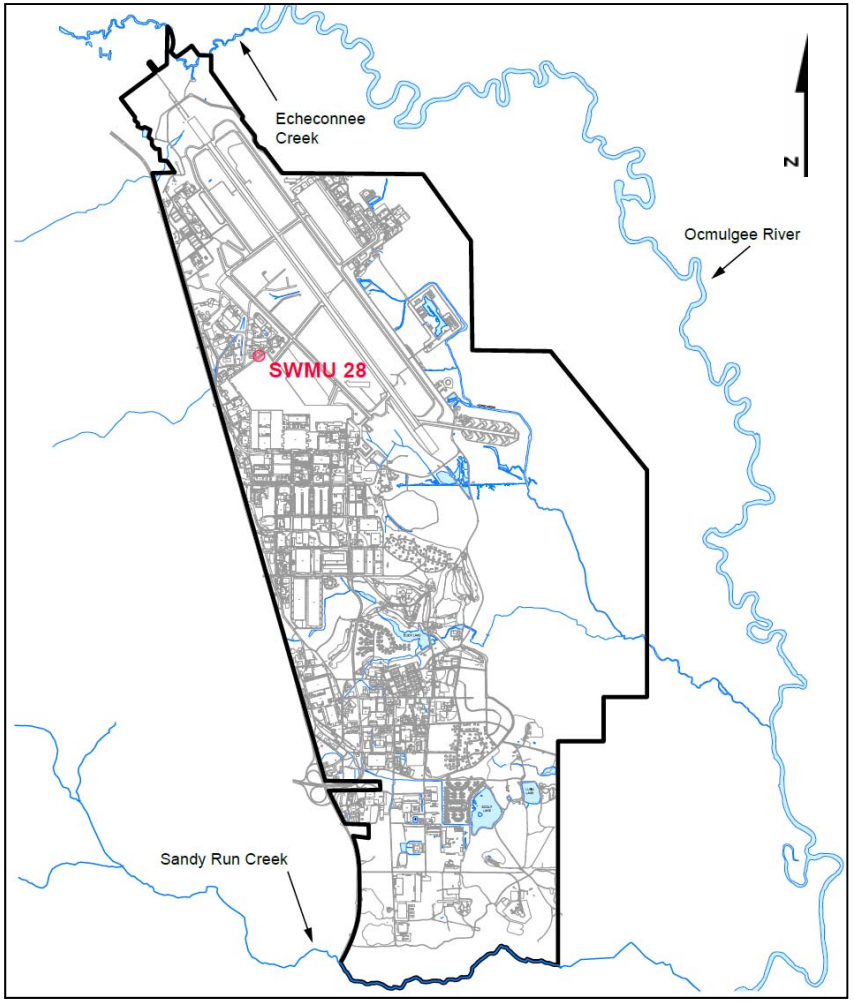
- Background
- Contract goals and remedy
- Enhanced Fluid Recovery (EFR®) and SURFAC® effectiveness
- Revised approach
- Full scale results
- Light Non-Aqueous Phase Liquid (LNAPL) rebound monitoring
- Potable water flush/groundwater extraction

Overview

- Surfactant Enhanced Aquifer Remediation (SEAR) progress
- Post-flush LNAPL rebound monitoring
- Passive Skimmer Pump / Absorbent Sock Performance
- Groundwater concentrations
- Path forward

Background

- Site of fuel release from purge fluid tanks; purge fluid is used to empty aircraft fuel tanks prior to maintenance
- Contamination consists of free product and dissolved petroleum hydrocarbons in groundwater



Background

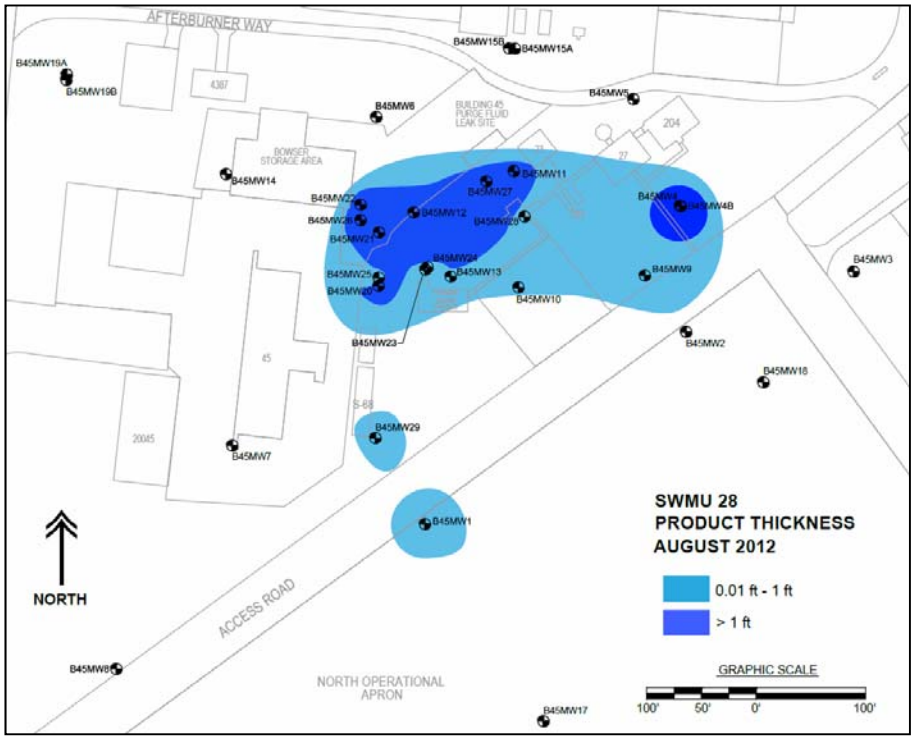
- Shallow, sandy aquifer with high dissolved oxygen concentrations results in high natural attenuation rates at edges of dissolved hydrocarbon plume
- Depth to groundwater = 15 feet
- Pre-PBR remedy: Product recovery conducted 1999 to 2012

Contract Goals and Remedy

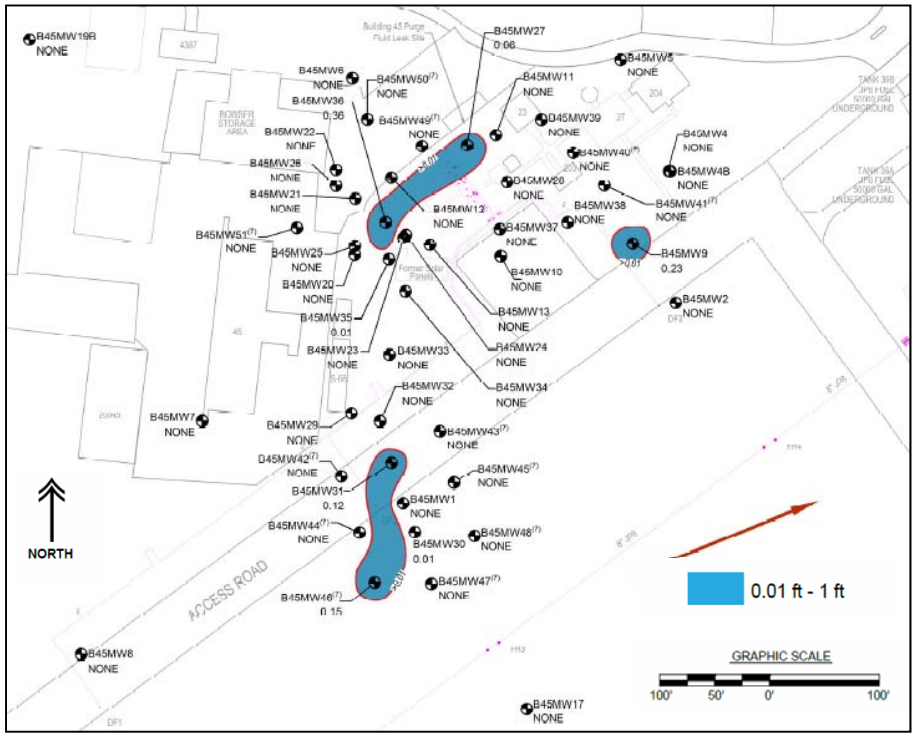
- **Contract Goals:**
  - **Achieve 100 percent removal of free product in all wells**
  - **Achieve groundwater RL by 2020**
- **PBR remedy to achieve contract goals: EFR® and surfactant flushing**
- **EFR® and surfactant flushing conducted August 2012 – February 2015; LNAPL thicknesses rebounded in October 2015**
- **Revised PBR Remedy: SEAR**

EFR® and SURFAC® Effectiveness

Prior to EFR® (2012)

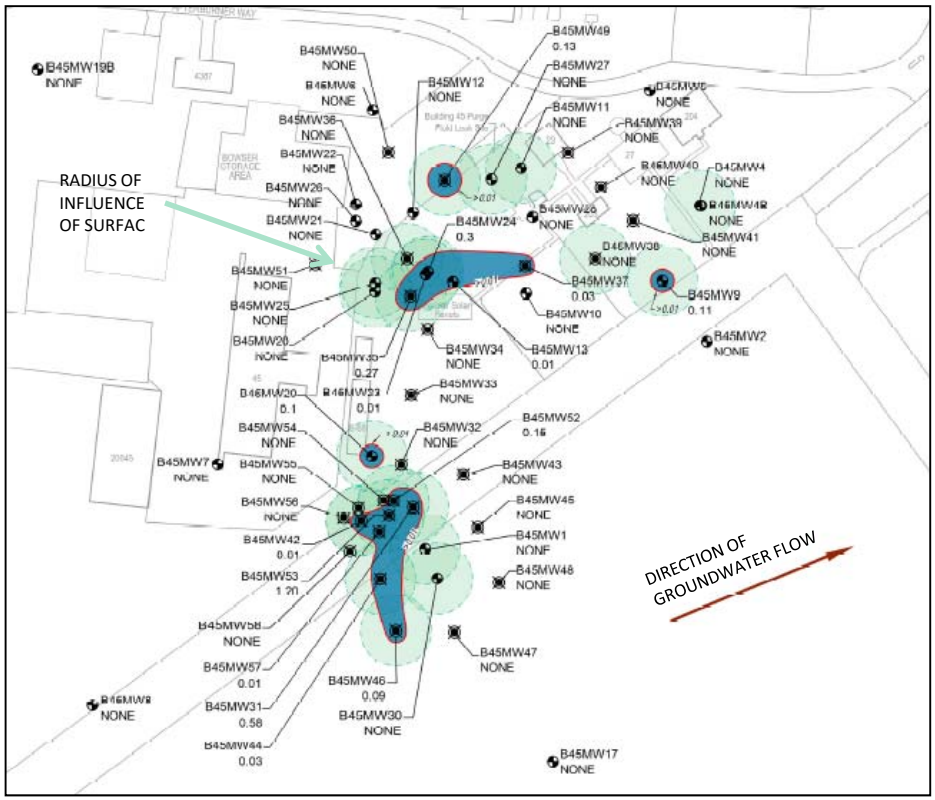


After Event #3 (2013)

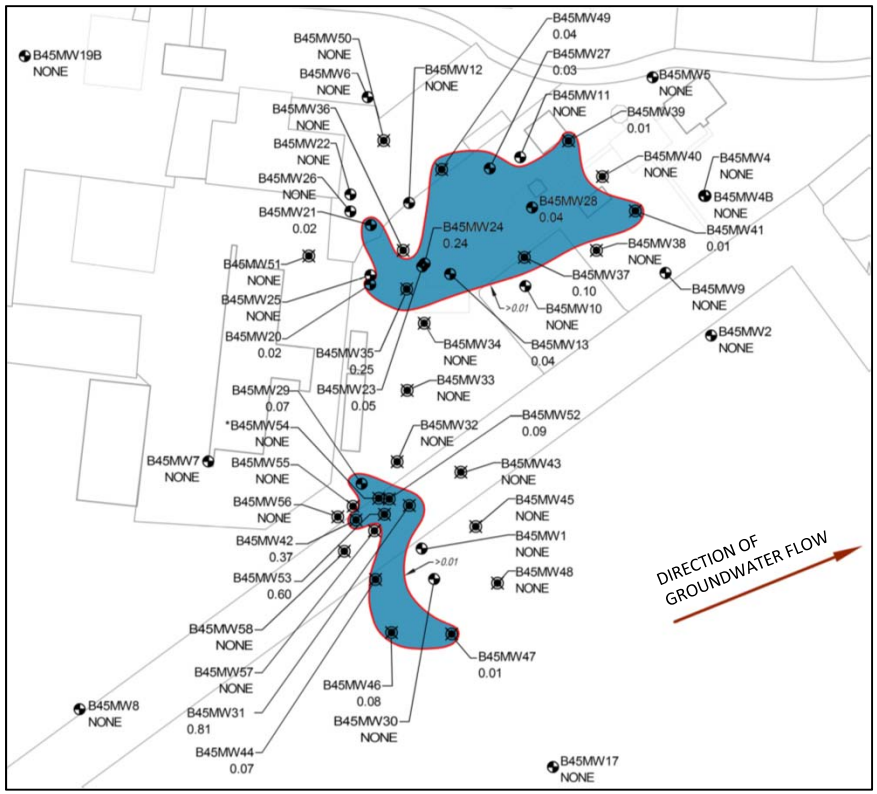


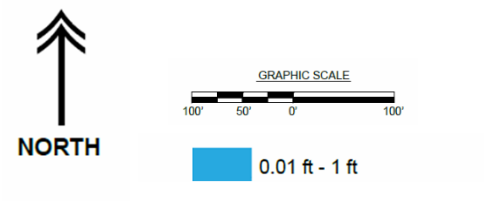
EFR® and SURFAC® Effectiveness

2015 Rebound



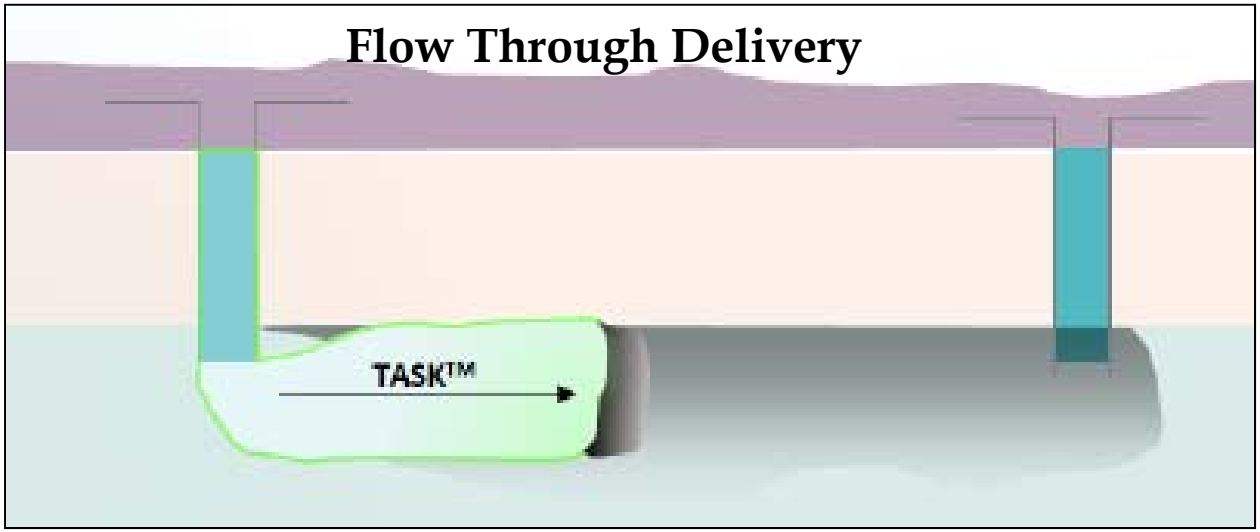
June 2016 Product Thickness





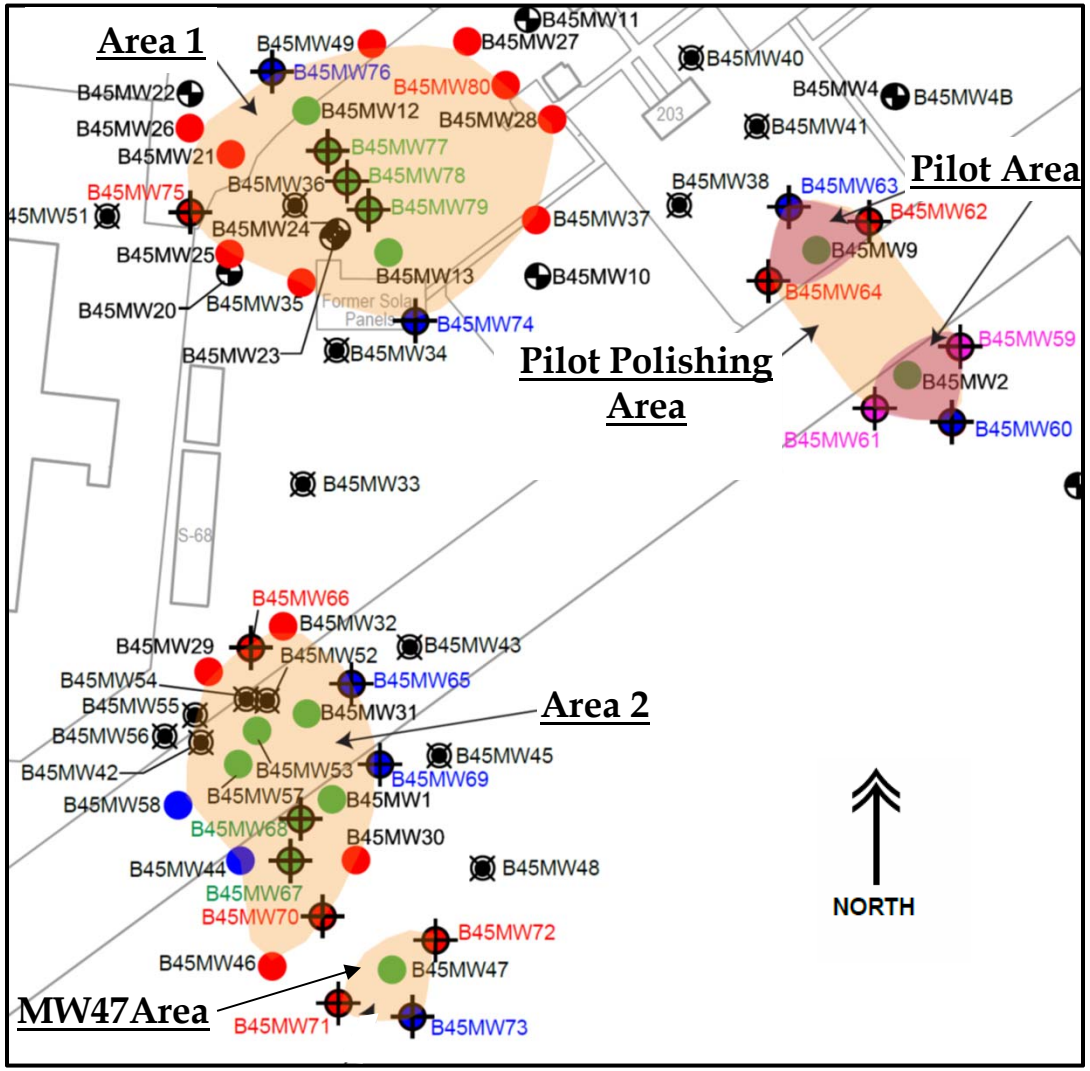
Revised Approach

- Change surfactant formula and delivery method to contact and remove more free product
- Non-emulsifying surfactant allows free product to be removed from waste stream, reducing disposal costs
- Continuous "flow through" delivery method achieves better removal of free product than "push-pull" method



Revised Approach

Treatment Areas



LEGEND

- EXISTING UPPER PROVIDENCE MONITORING WELL (NO PROPOSED INJECTION OR EXTRACTION)
- EXISTING UPPER PROVIDENCE INJECTION/EXTRACTION WELL (NO PROPOSED INJECTION OR EXTRACTION)
- EXISTING UPPER PROVIDENCE MONITORING WELL OR INJECTION/EXTRACTION WELL TO BE USED FOR INJECTION
- EXISTING UPPER PROVIDENCE MONITORING WELL OR INJECTION/EXTRACTION WELL TO BE USED FOR EXTRACTION
- EXISTING UPPER PROVIDENCE MONITORING WELL OR INJECTION/EXTRACTION WELL TO BE USED FOR HYDRAULIC CONTROL
- SEAR TREATMENT AREA, FULL SCALE
- SEAR TREATMENT AREA, PILOT
- NEW UPPER PROVIDENCE INJECTION WELL
- NEW UPPER PROVIDENCE EXTRACTION WELL
- NEW UPPER PROVIDENCE HYDRAULIC CONTROL WELL
- NEW UPPER PROVIDENCE HYDRAULIC CONTROL AND EXTRACTION WELL (TWO INJECTION SCHEMES)

Revised Approach

- Site-Specific Phase Behavior Study: June 2016
- Hydraulic Model: July 2016
- Installation of Additional Injection/Extraction Wells: September – October 2016
- Pilot Study: December 2016 – February 2017
- Pilot Study Evaluation and System Modifications: March – May 2017
- Full Scale: May – August 2017

Revised Approach

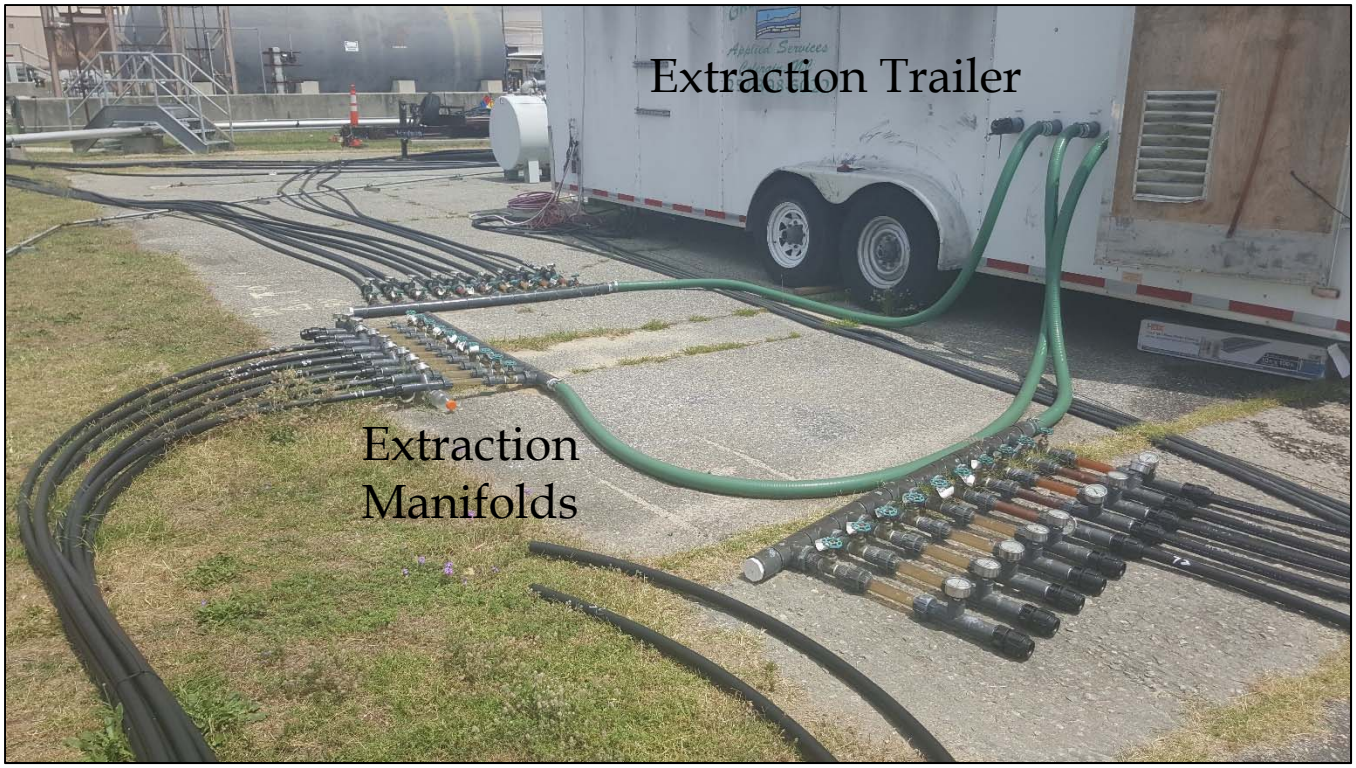
- **LNAPL Rebound Monitoring: September – October 2017**
- **Potable Water Flush/Groundwater Extraction: November 2017**
- **LNAPL Rebound Monitoring/Passive Recovery: December 2017 – Current**

Full Scale Results

- May – August 2017
- Injected 1,830,000 gallons of surfactant, polymer, and potable water
- Extracted 1,570,000 gallons of groundwater, surfactant, polymer, and product
- Field measurements of salt (conductivity) used to track surfactant breakthrough in extraction wells
- Full scale completed when design injection quantities were achieved and elevated conductivity measurements were observed in extraction wells

Full Scale Results

SWMU 28 Surfactant Injection / Extraction System Photographs

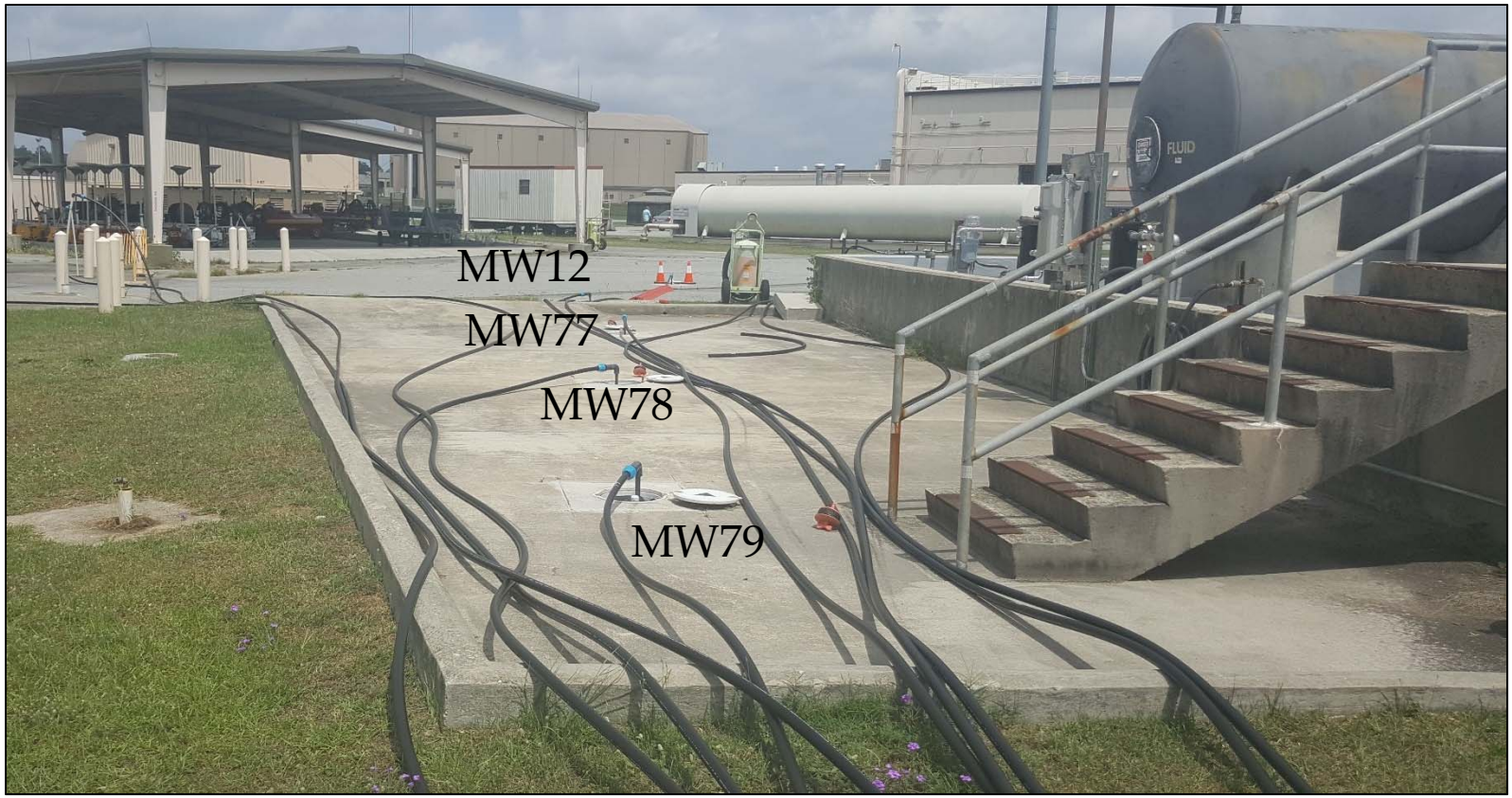


Photograph Direction: Northeast

Full Scale Results

SWMU 28 Surfactant Injection / Extraction System Photographs

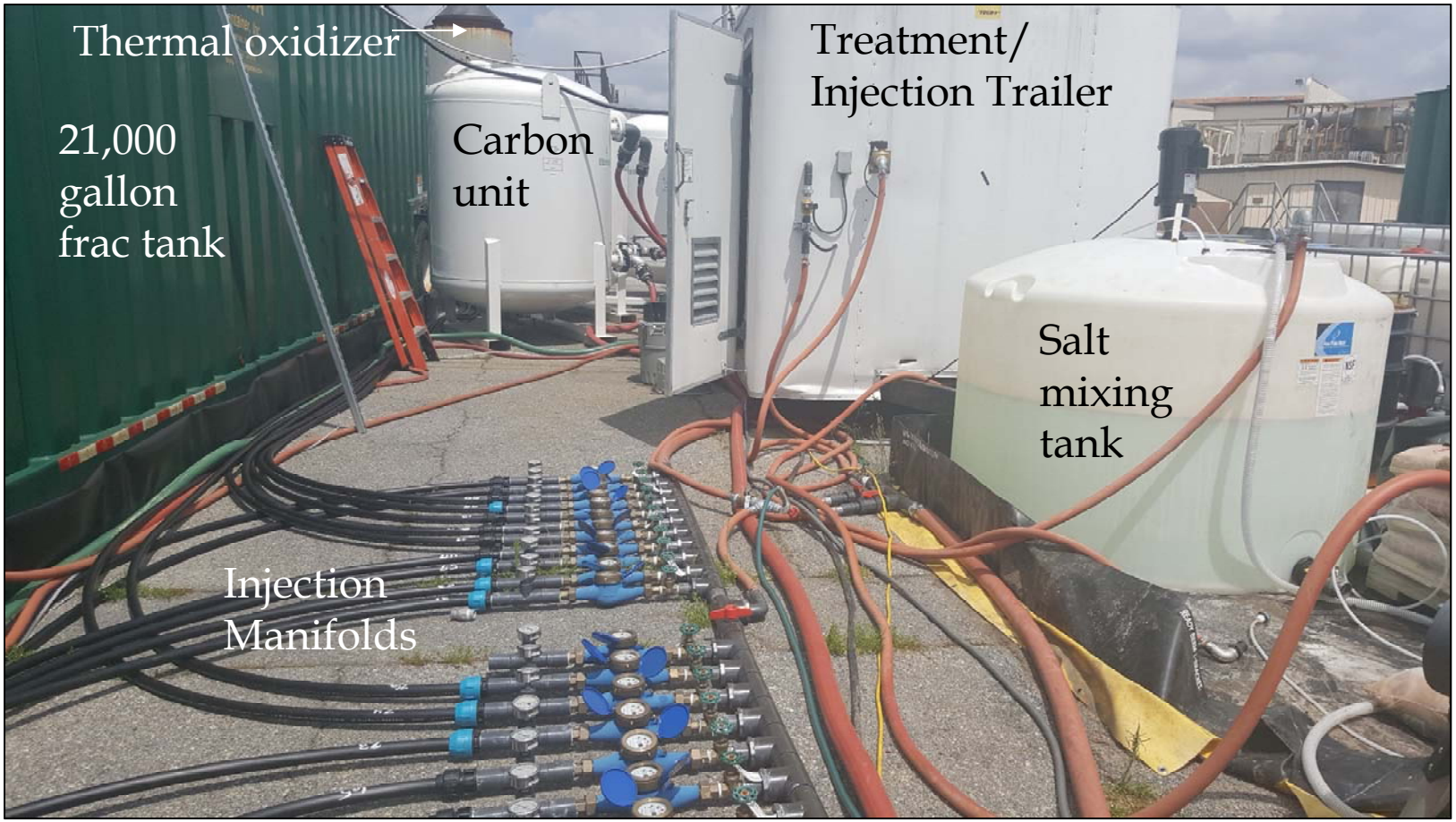
Area 1 Injection Wells



Photograph Direction: North

Full Scale Results

SWMU 28 Surfactant Injection / Extraction System Photographs



Photograph Direction: North

LNAPL Rebound Monitoring

- LNAPL rebound monitoring conducted four weeks after SEAR in September 2017
- LNAPL observed in 22 wells at thicknesses ranging from 0.01 feet to 0.41 feet
- Cumulative (site-wide total) LNAPL thickness from September 2017 was 2.85 feet compared to the pre-SEAR cumulative LNAPL thickness of 11.67 feet
- Cumulative thickness reduced by 76 percent

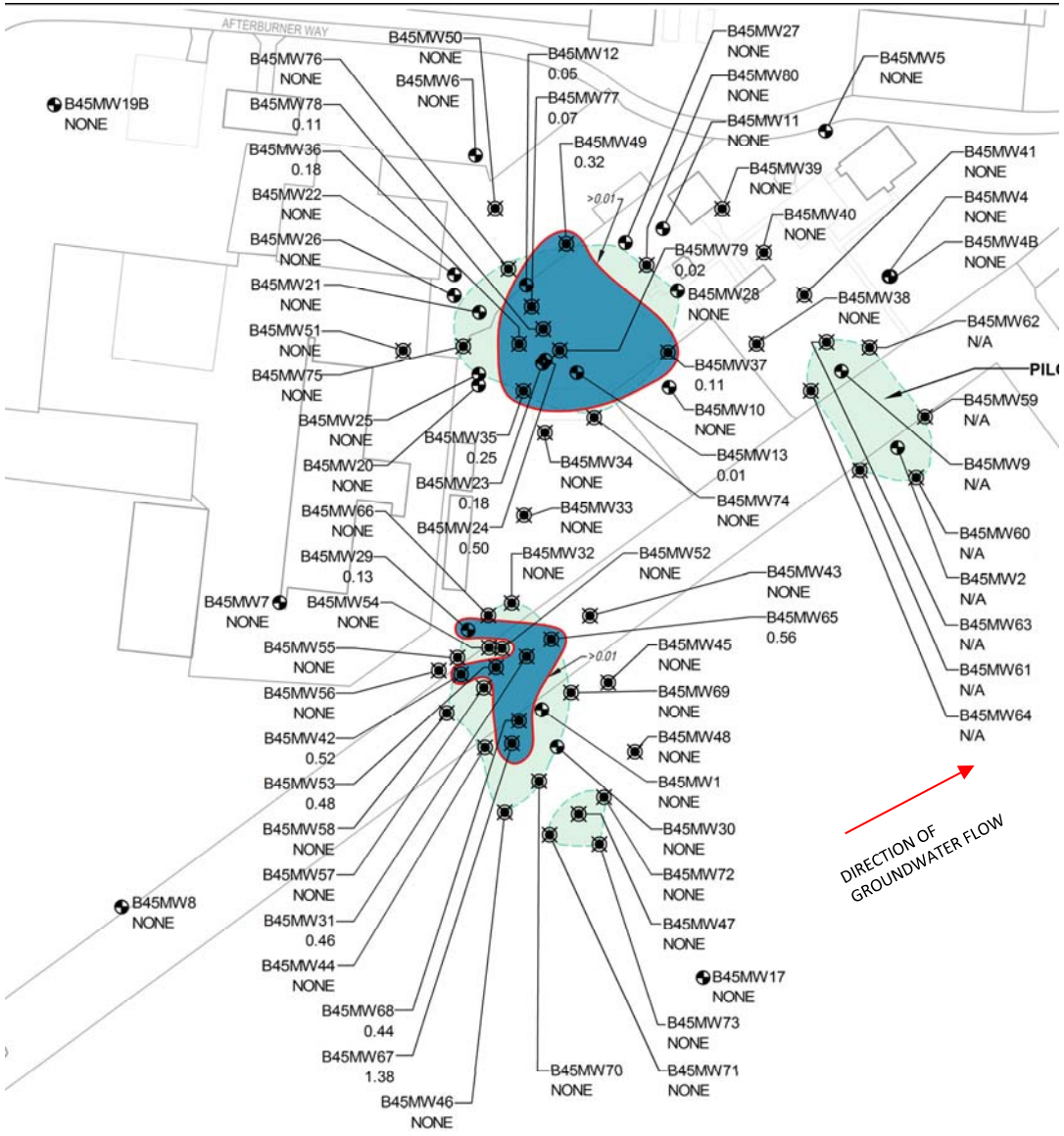
LNAPL Rebound Monitoring

- LNAPL was observed only in wells used as extraction wells during SEAR; Prior to SEAR, LNAPL was observed in injection wells
- Results suggest that previously trapped LNAPL pockets had been mobilized to extraction points, but additional recovery was needed to complete LNAPL removal

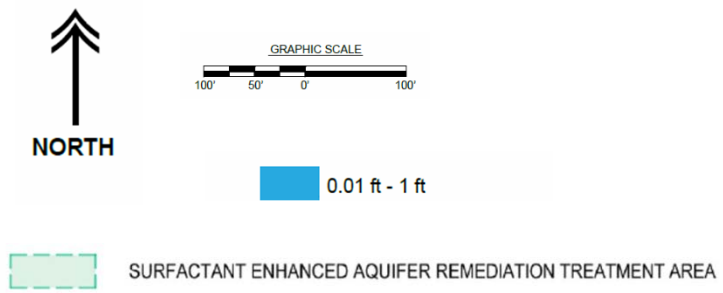
Potable Water Flush / Groundwater Extraction

- Potable water flush/groundwater extraction event conducted November – December 2017
- Injected 327,000 gallons of potable water
- Extracted 354,000 gallons of groundwater, surfactant, and product
- Approximately 2,000 gallons of LNAPL were recovered from SEAR and potable water flush activities

SEAR Progress



LNAPL THICKNESS PRIOR TO FULL SCALE SEAR – MARCH 2017

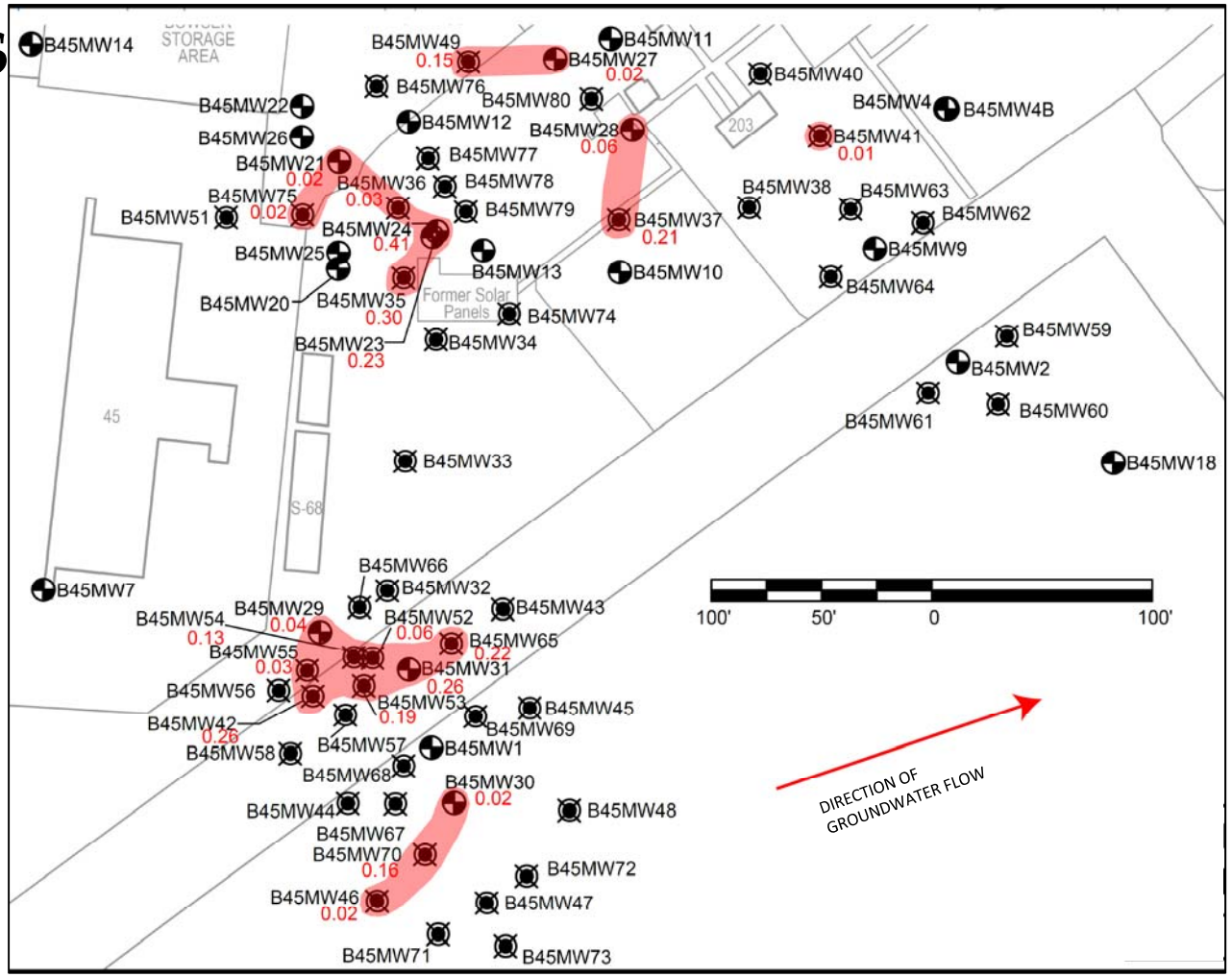


SEAR Progress

LNAPL THICKNESS AFTER FULL SCALE SEAR – SEPTEMBER 2017

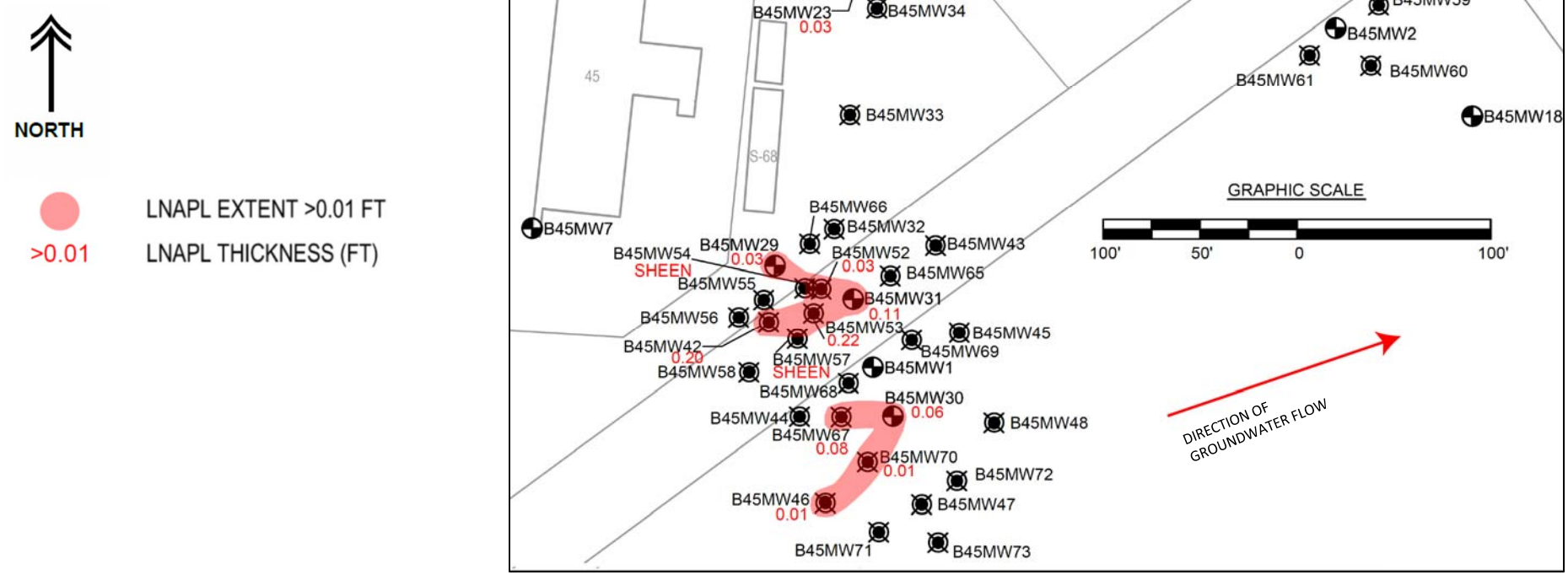
LNAPL EXTENT >0.01 FT

>0.01 LNAPL THICKNESS (FT)



SEAR Progress

LNAPL THICKNESS AFTER POTABLE WATER FLUSH – JANUARY 2018



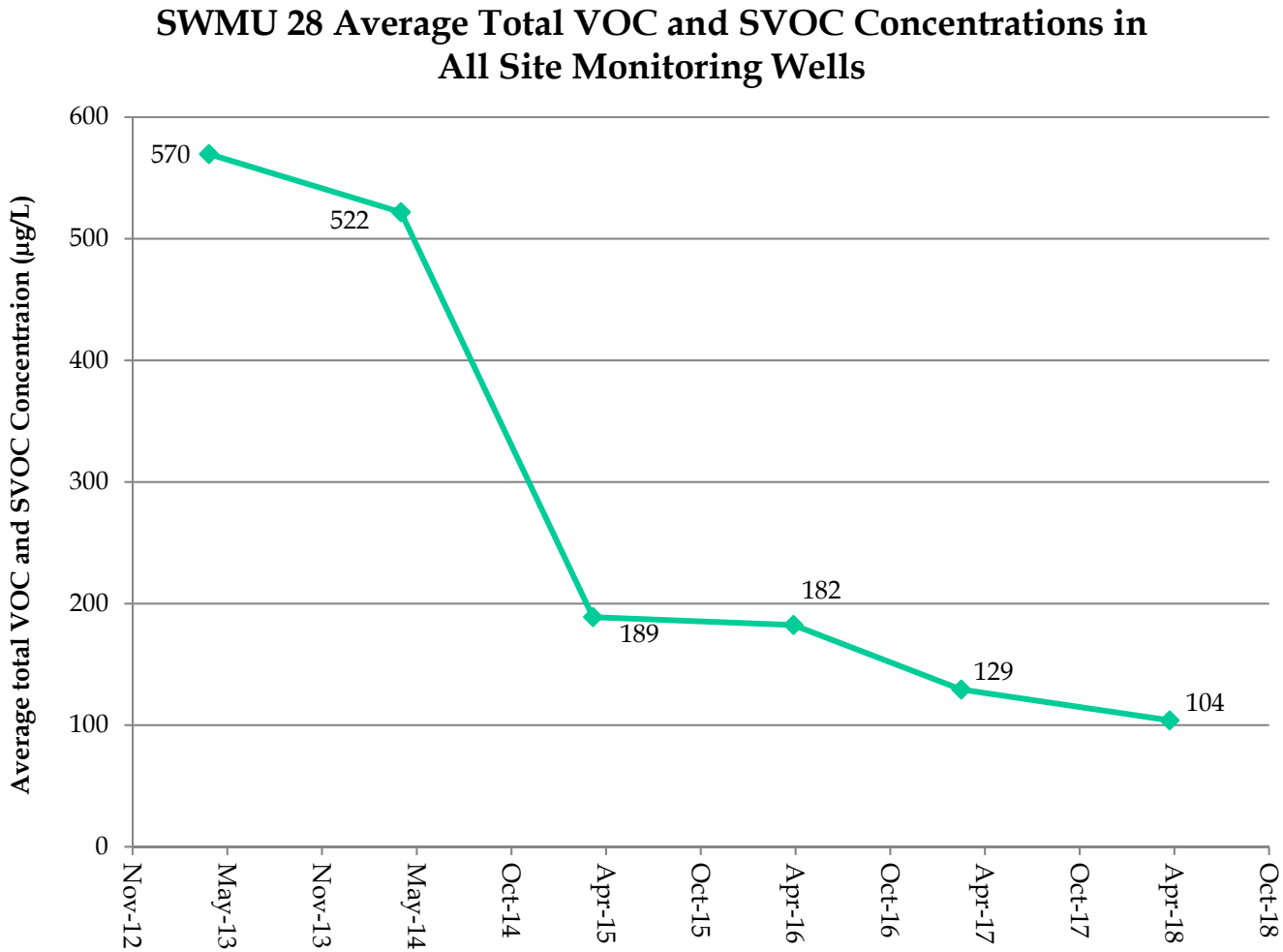
Post-Flush LNAPL Rebound Monitoring

- Results indicated similar LNAPL thicknesses to those observed before the potable water flush
- Therefore, no additional rounds of injections and/or groundwater extraction were recommended
- Using January 2018 gauging data, passive skimmer pumps and absorbent socks were recommended as polishing step

Passive Skimmer Pump / Absorbent Sock Performance

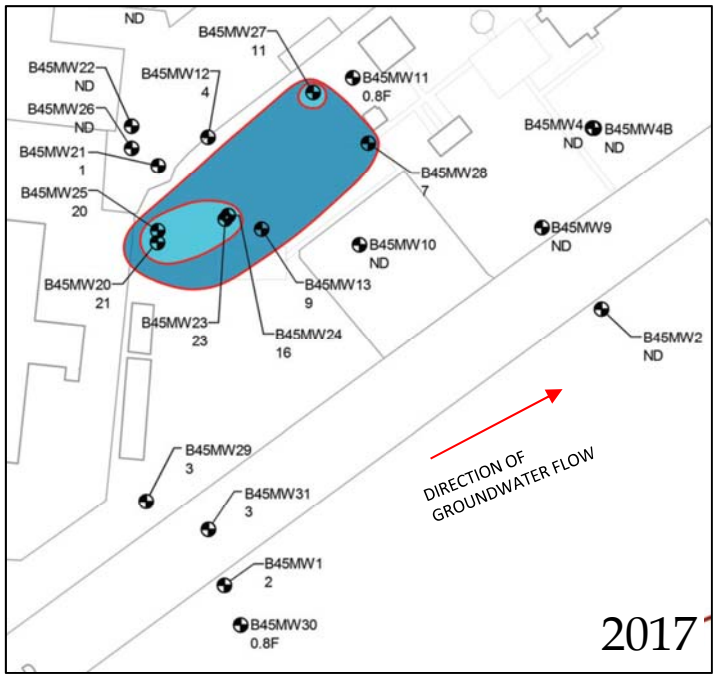
- Passive skimmers and absorbent socks deployed on February 6, 2018
- Since deployment, LNAPL thicknesses have generally been 0.01 feet or less in most wells
- LNAPL recovery in passive skimmers and absorbent socks have been monitored monthly
- As remaining LNAPL diminishes, passive skimmers and absorbent socks are removed from wells

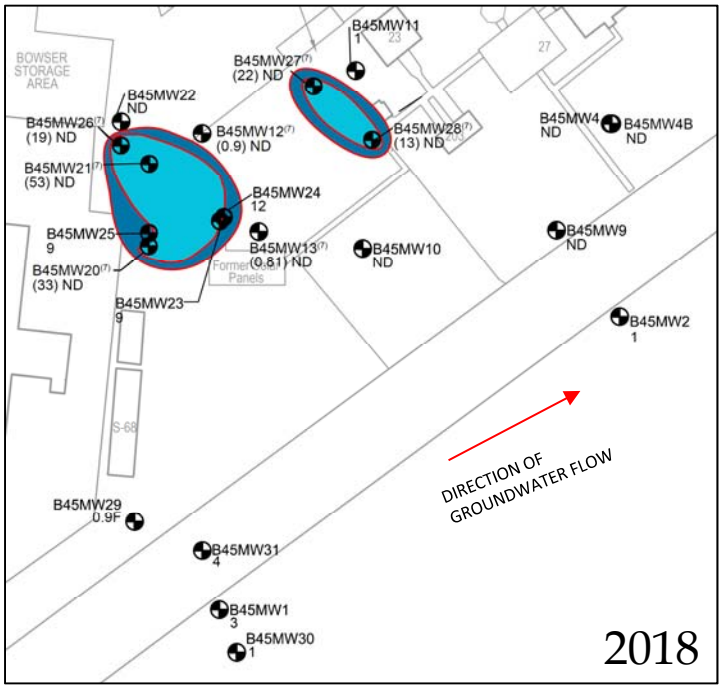
Groundwater Concentrations

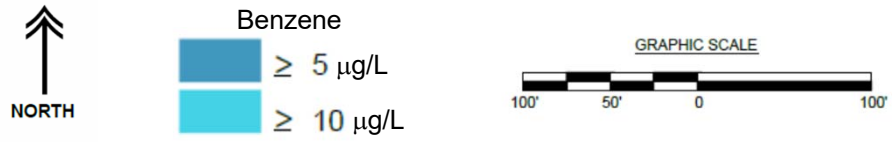


Groundwater Concentrations

- **March 2018: Nine of 27 wells have COC concentrations above RLs**







Groundwater Concentrations

- Significant COC concentration decreases (52 – 94 percent) in groundwater were observed in four wells in which LNAPL was detected in 2016, but no longer present in 2018
- Results suggest that contaminant concentrations in groundwater decrease in wells after LNAPL is no longer detected
- Geochemical data collected in March 2018 indicate natural biodegradation processes are present at SWMU 28

Path Forward

- Conduct monthly free product gauging
- Remove skimmer pumps and absorbent socks when LNAPL is no longer observed in a well
- Achieve 100 percent removal of free product
- Continue groundwater monitoring
- Achieve remedial levels in all wells (2020)

New Business
and
Program Closing

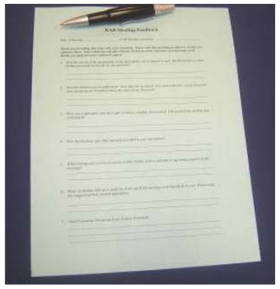
Dr. Linda Smyth
EAB Community Co-chair

Next EAB Meeting

Thursday, 2 May 2019

Please…

Complete the meeting evaluation and feedback form and leave at your seat



Leave your name tag at the sign-in table for the next meeting

Thank you!