Welcome

Environmental Advisory Board (EAB) Meeting

Robins Air Force Base

August 4, 2022

Welcome and Program Introduction

Ms. Shan Williams
EAB Installation Co-chair

Acronyms and Abbreviations

- AS – Air Sparge
- CAP – Corrective Action Plan
- COC – Contaminant of Concern
- CSM – Conceptual Site Model
- CT – Carbon Tetrachloride
- DPT – Direct Push Technology
- EAB – Environmental Advisory Board
- GA EPD – Georgia Environmental Protection Division
- GWTP – Groundwater Treatment Plant
- HDD – Horizontal Directional Drilled
- HPT – Hydraulic Profiling Tool
- ISCO – In-situ Chemical Oxidation
- iSOC – In-situ Oxygen Curtain
- JP-4 – Jet Propellant Number 4
- $KMnO_4$ – Potassium Permanganate

Acronyms and Abbreviations

- LIF – Laser-Induced Fluorescence
- LNAPL – Light Non-Aqueous Phase Liquid
- MIP – Membrane Interface Probe
- µg/kg – microgram per kilogram
- µg/L – microgram per liter
- MFR – Modified Fenton's Reagent
- MNA – Monitored Natural Attenuation
- ORC – Optimized Remediation Contract
- PCE – Tetrachloroethene
- PoP – Period of Performance
- Q – Quarter
- RCRA – Resource Conservation and Recovery Act
- RD/RA – Remedial Design/Remedial Action
- RL – Remediation Level
- ROST – Rapid-Optical Screening Tool

Acronyms and Abbreviations

- **SPOC – Shock-Protected Optical Compartment**
- **SSI – Supplemental Site Investigation**
- **SVE – Soil Vapor Extraction**
- **SWMU – Solid Waste Management Unit**
- **TCE – Trichloroethene**
- **UFP-QAPP – Uniform Federal Policy – Quality Assurance Project Plan**
- **VOC – Volatile Organic Compound**

Solid Waste Management Units (SWMUs) 59 & 60 (CG501 & CG502) – Update on Progress

Kip Gray, PhD
Project Engineer
Geosyntec Consultants, Inc.

August 4, 2022

Overview

- Site history
- Site investigations
- CAP Addendum
- Remedial design
- Path forward

Site History

- Located in flightline area
- 1995: Petroleum contamination discovered due to presumed historical release(s) from active/inactive buried fuel lines
- Inactive fuel line transported Jet Propellant Number 4 (JP-4) until mid-1990s and abandoned in place in 2000
- Active fuel line transported JP-4 until mid-1990s when Robins AFB converted to JP-8 for aircraft fueling
- Historical release of light non-aqueous phase liquid (LNAPL) resulted in groundwater plume
- Numerous investigations have found no evidence of ongoing leak

SWMU 59 and 60 Location

Site History

- **2002: Corrective Action Plan (CAP) Objectives**
  - SWMU 59 and 60 combined CAP due to proximity and similar nature of contamination
  - Reduce residual LNAPL to minimize continued release of fuel-related constituents into groundwater
  - Reduce or control fuel-related volatile organic compounds (VOCs), including benzene, in source area groundwater
  - Minimize downgradient migration of VOCs in groundwater

Contaminants of Concern (COCs)

Parameter	SWMU 59 Groundwater RL (µg/L)	SWMU 60 Groundwater RL (µg/L)
Volatile Organics		
1,2,4-Trimethylbenzene	12	12
1,3,5-Trimethylbenzene	12	12
Benzene	5	5
Toluene	1,000	1,000
Ethylbenzene	700	700
n-Propylbenzene	--	240
Semivolatile Organics		
Naphthalene	6.5	6.5

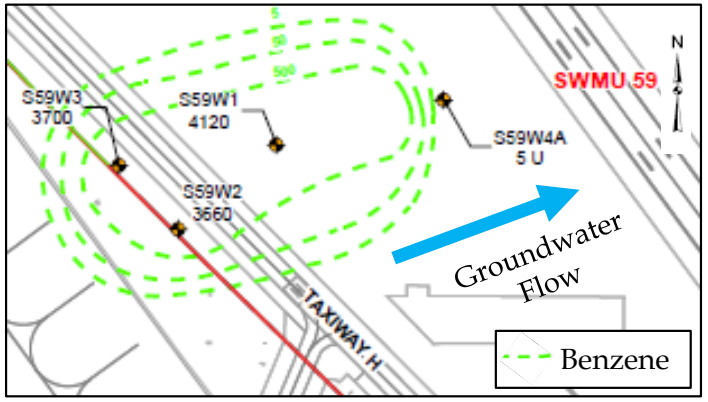
Parameter	SWMU 59 Soil RL (µg/kg)
Volatile Organics	
1,2,4-Trimethylbenzene	117
1,3,5-Trimethylbenzene	63
Benzene	120
Toluene	24,000
Ethylbenzene	22,700
m,p-Xylene	357,000
n-Propylbenzene	788
Semivolatile Organics	
Naphthalene	--

Notes:
RL = Remediation Level
µg/L = micrograms per liter
µg/kg = micrograms per kilogram

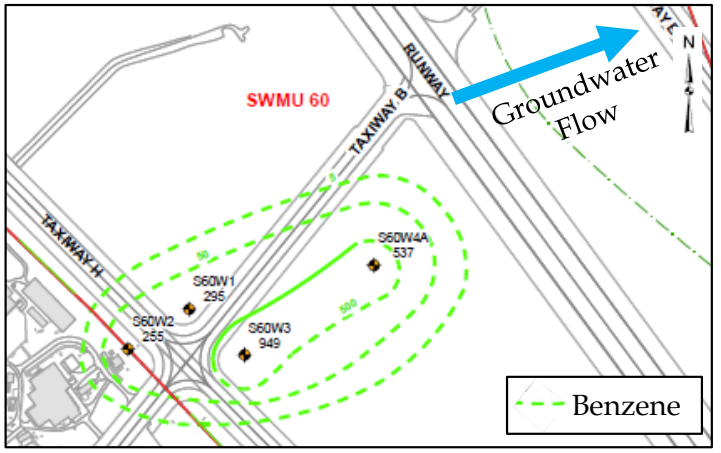
Source: CAP (CAPE, 2001)

Site History

- **2002: CAP components**
  - Air sparge and soil vapor extraction (AS/SVE) selected for source areas
    - AS: air injected at high flow rates strips contaminants from dissolved to vapor phase
    - SVE: vacuum enhances stripping while capturing contaminant vapor for above ground treatment
  - Monitored Natural Attenuation (MNA) for downgradient areas
    - MNA: natural processes, including biodegradation, that reduce contaminant mass and toxicity without human intervention
- **2003: AS/SVE system installed and started**
  - Four AS/SVE arrays installed at each SWMU



SWMU 59 Groundwater Plume (1999)



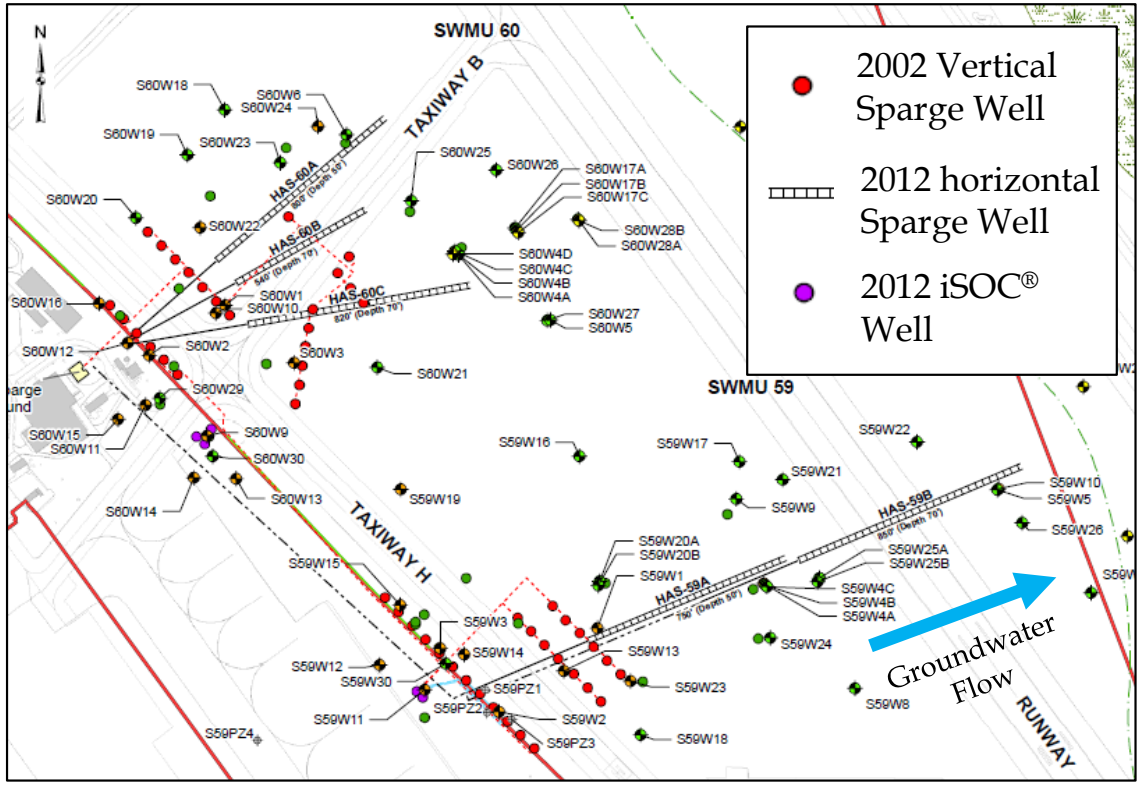
SWMU 60 Groundwater Plume (1999)

Site History

- **2012 – 2013: System modified due to diminishing decreases in contamination**
  - AS converted to biosparge by reducing air injection flowrate
    - Biosparging enhances natural biodegradation of contaminants below ground surface by replenishing dissolved oxygen
  - SVE shut down
    - SVE no longer required as VOCs are biodegraded below ground surface

Site History

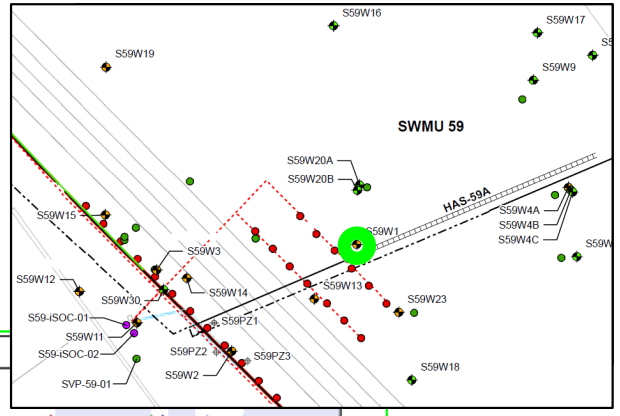
- **2012 – 2013: System enhanced due to diminishing decreases in contamination**
  - Horizontal directional drilled (HDD) biosparge wells installed to expand treatment area downgradient
    - HDD wells have long screens that can treat much larger areas than vertical wells
  - In-situ submerged oxygen curtains (iSOC®) to expand treatment area upgradient
    - iSOC® wells also designed to replenish dissolved oxygen

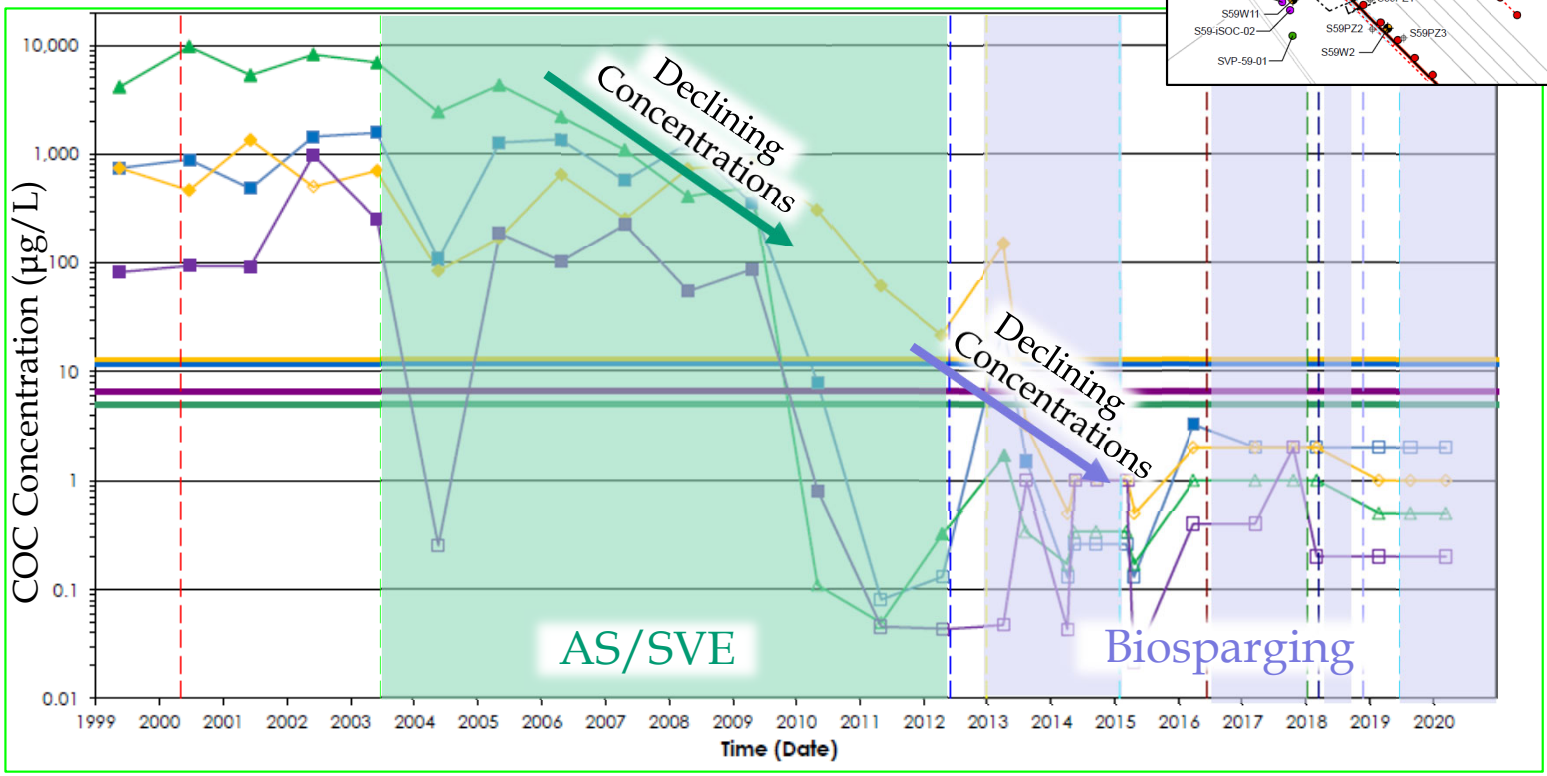


SWMU 59 and 60 Remediation System (Present Day)

Site History

- **Post-2013 performance:**
  - Biosparging effective at decreasing concentrations in locations within radius of influence



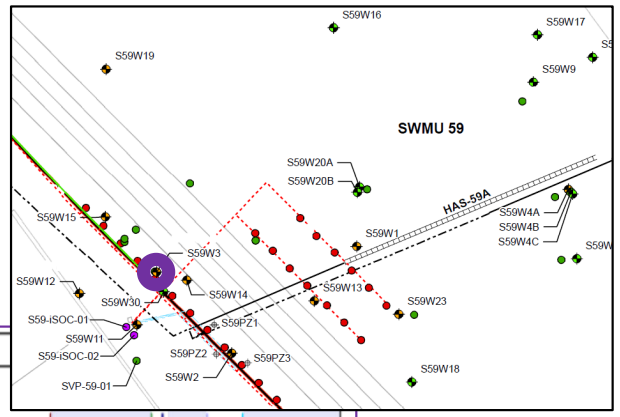


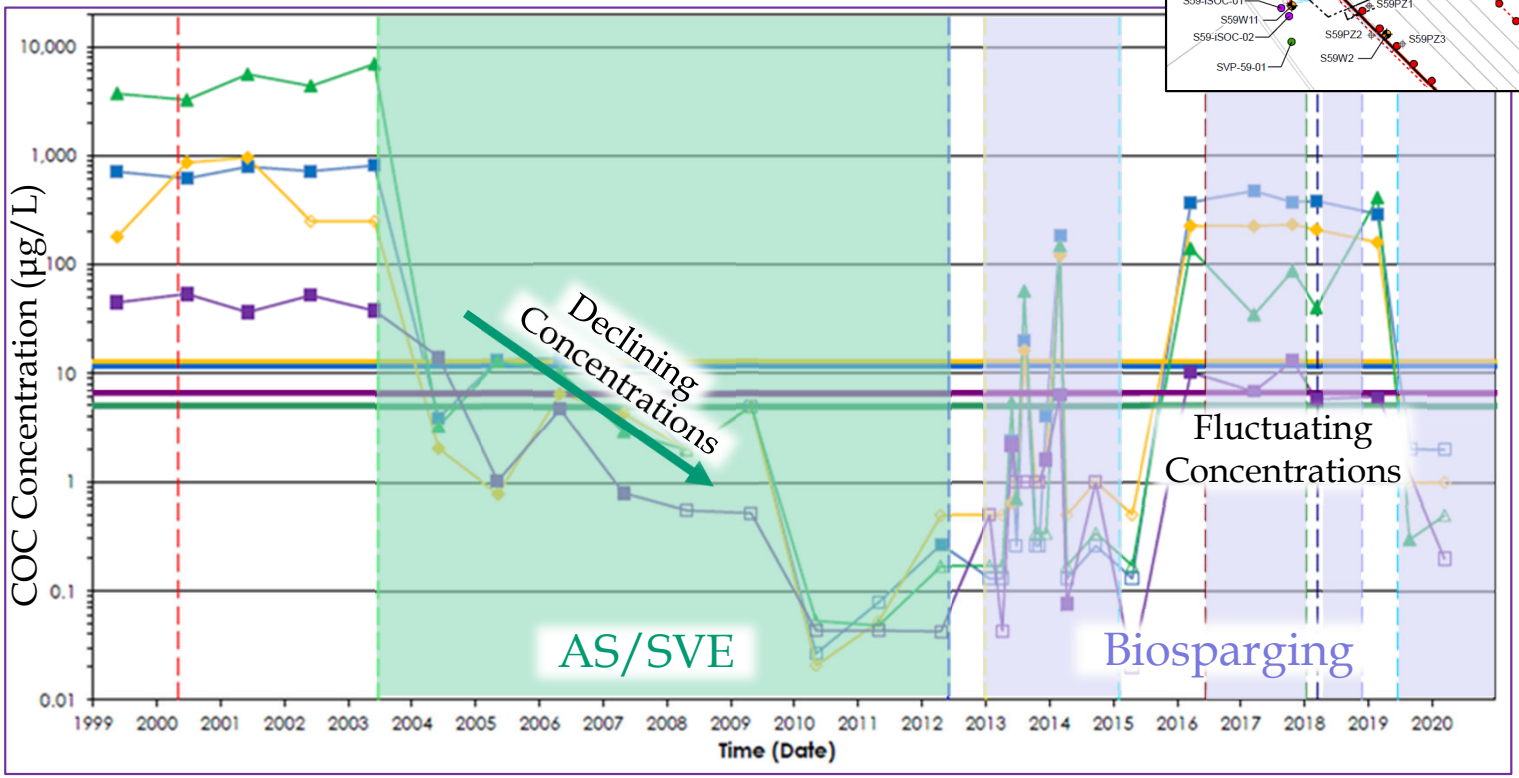
S59W1 COC Concentrations over Time

1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Benzene
Naphthalene
1,2,4-Trimethylbenzene RL: 12 µg/L
1,3,5-Trimethylbenzene RL: 12 µg/L
Benzene MCL: 5 µg/L
Naphthalene RL: 6.5 µg/L
SVE System Shut down – June 2012
Biosparge System Shutdown for Emissions Issue – 5 February 2015
Biosparge System Shutdown for UIC Permit Expiration – 12 January 2018
Biosparge System Shutdown – 29 November 2018
Horizontal Biosparge System Started – 31 December 2012
Biosparge System Restart – 13 June 2016
Biosparge System Restart – 19 March 2018
Biosparge System Restart – 26 June 2019

Site History

- **Post-2013 performance:**
  - Continued concentrations fluctuations in some locations suggest additional COC mass may be present outside influence of system





S59W3 COC concentrations over Time

1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Benzene
Naphthalene
1,2,4-Trimethylbenzene RL: 12 µg/L
1,3,5-Trimethylbenzene RL: 12 µg/L
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Biosparge System Restart – 26 June 2019

Site History

- **2014 – 2018: Supplemental Site Investigation (SSI)**
  - Additional groundwater monitoring wells installed at SWMU 59 (12 total) and SWMU 60 (8 total) to further refine plume extents

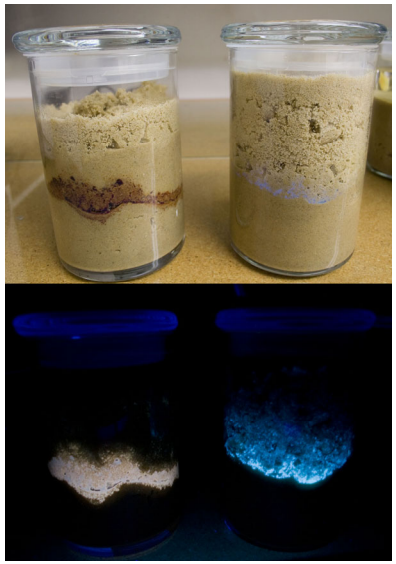
- **2018 – 2019: Source Area Investigation**
  - Focused investigation to identify potential contaminant source material during taxiway closure

  - Direct sensing contaminant profiling tools
    - Laser induced fluorescence (LIF)
    - Membrane interface probe (MIP)
    - Hydraulic profiling tool (HPT)
    - Groundwater and soil sampling with direct push technology (DPT)

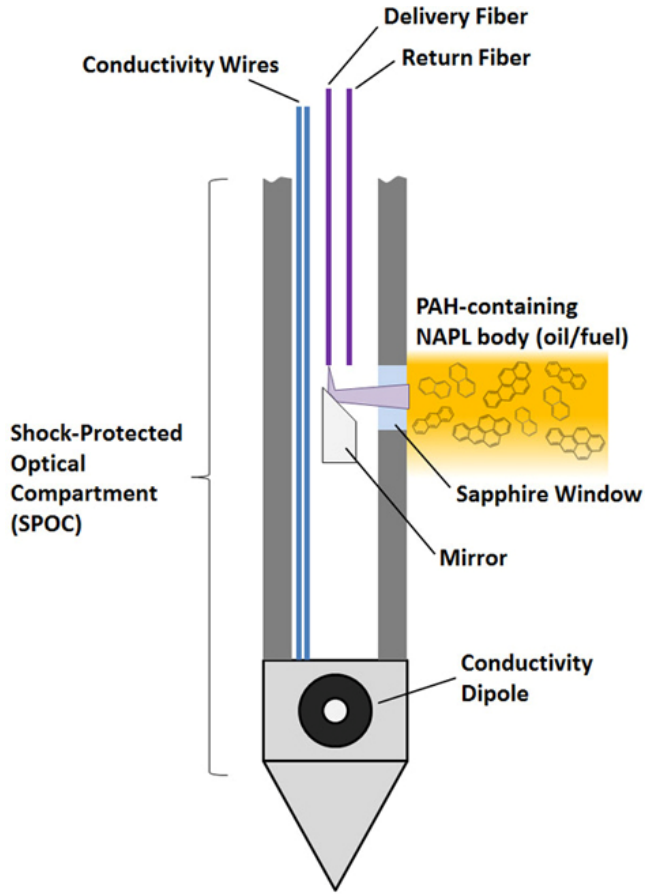
  - Discrete interval groundwater and soil sampling

Site Investigations

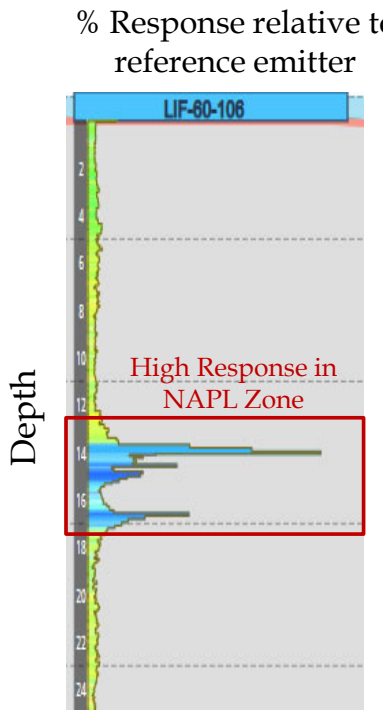
- **2018 – 2019: Source Area Investigation**
  - LIF can detect presence of NAPL and provide semiqualitative indication of source material in soil phase



Oil Florescence



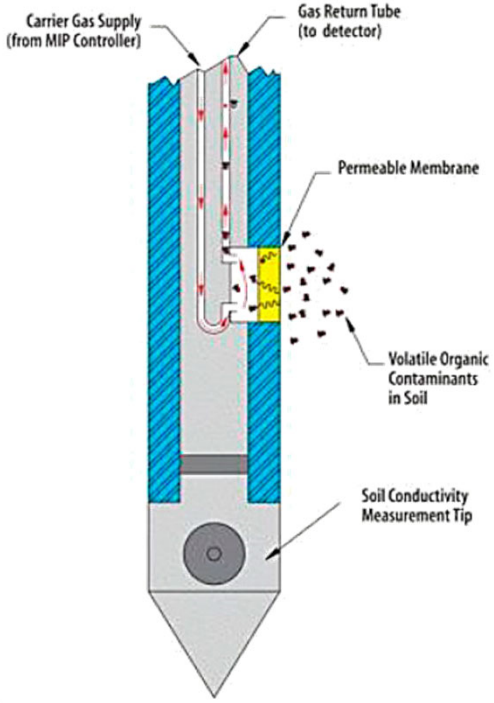
LIF Probe



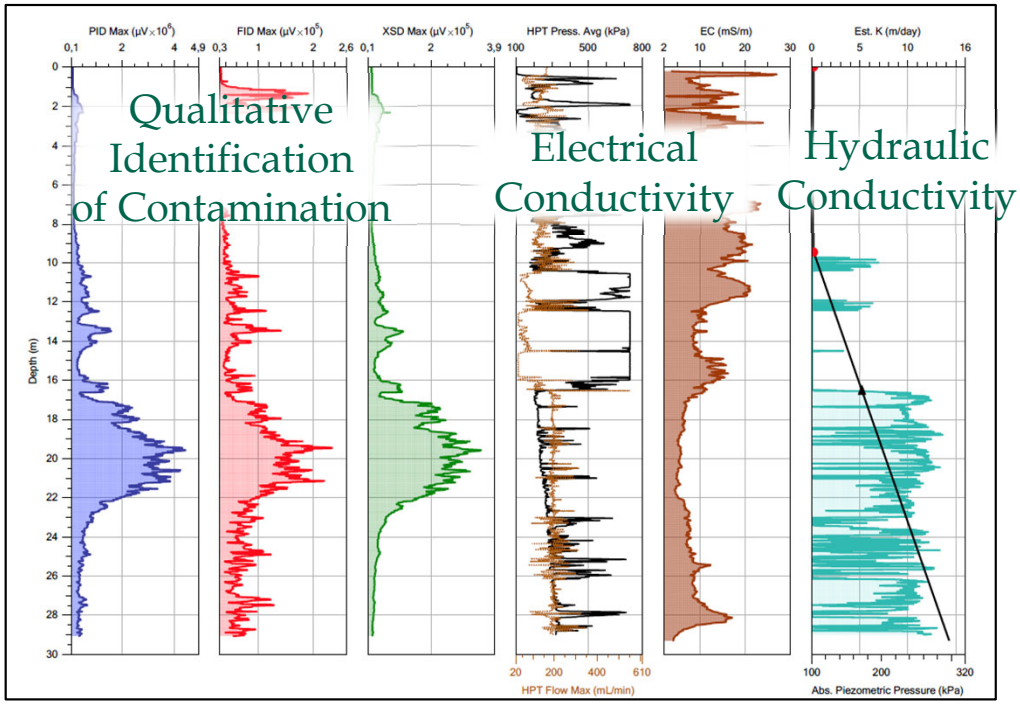
Typical LIF Data

Site Investigations

- **2018 – 2019: Source Area Investigation**
  - MIP can detect presence of dissolved contaminants and provide qualitative identification
  - HPT provides information on hydrogeology and can identify areas of contaminant transport and storage

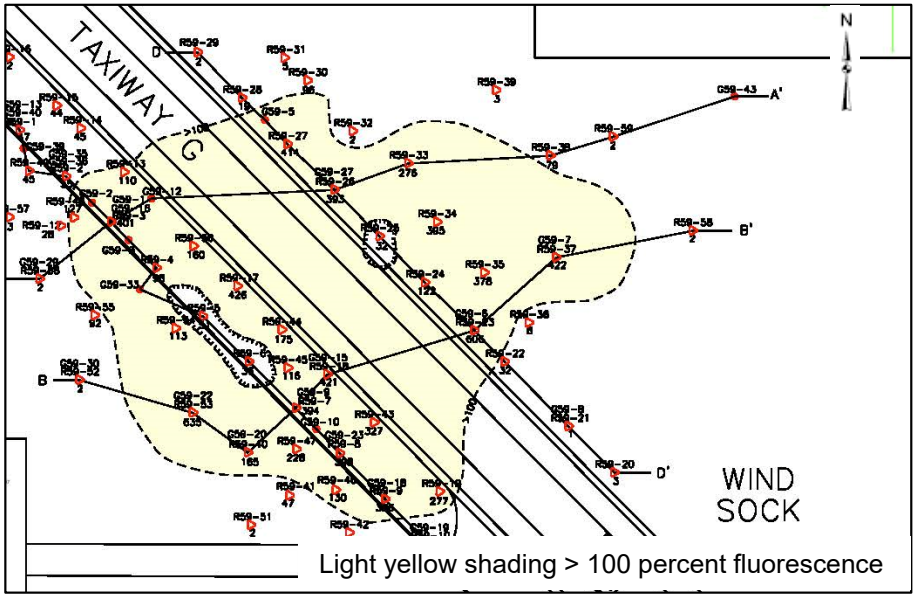


MIP

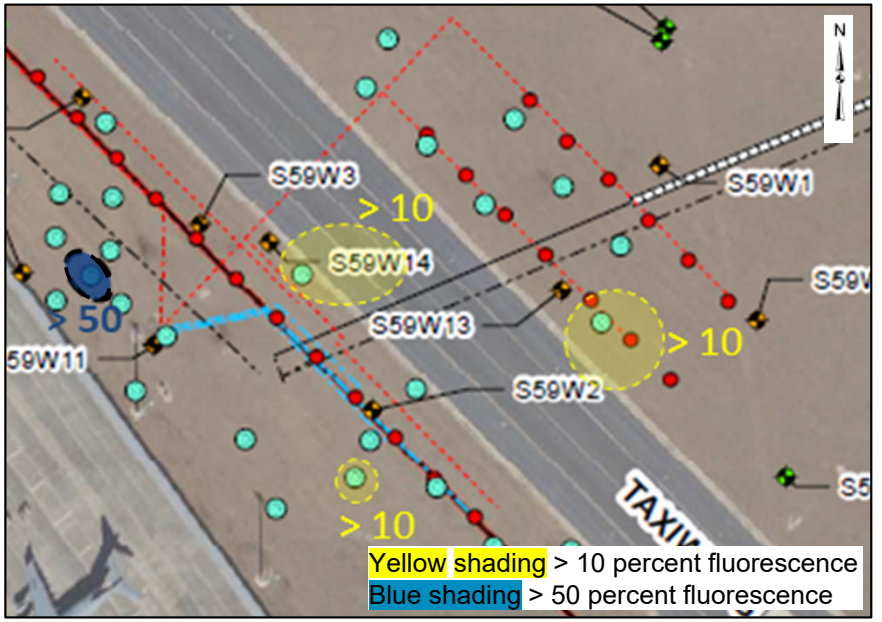


Typical MIP-HPT data

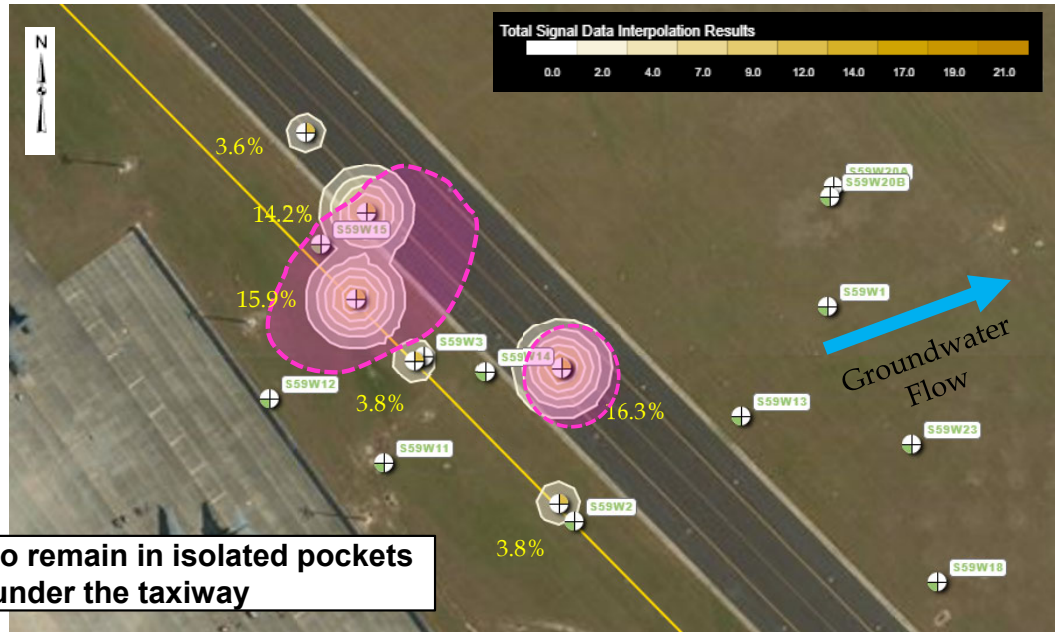
Site Investigations
(SWMU 59)



1997 Rapid Optical Screening Tool (ROST™)



2014 LIF



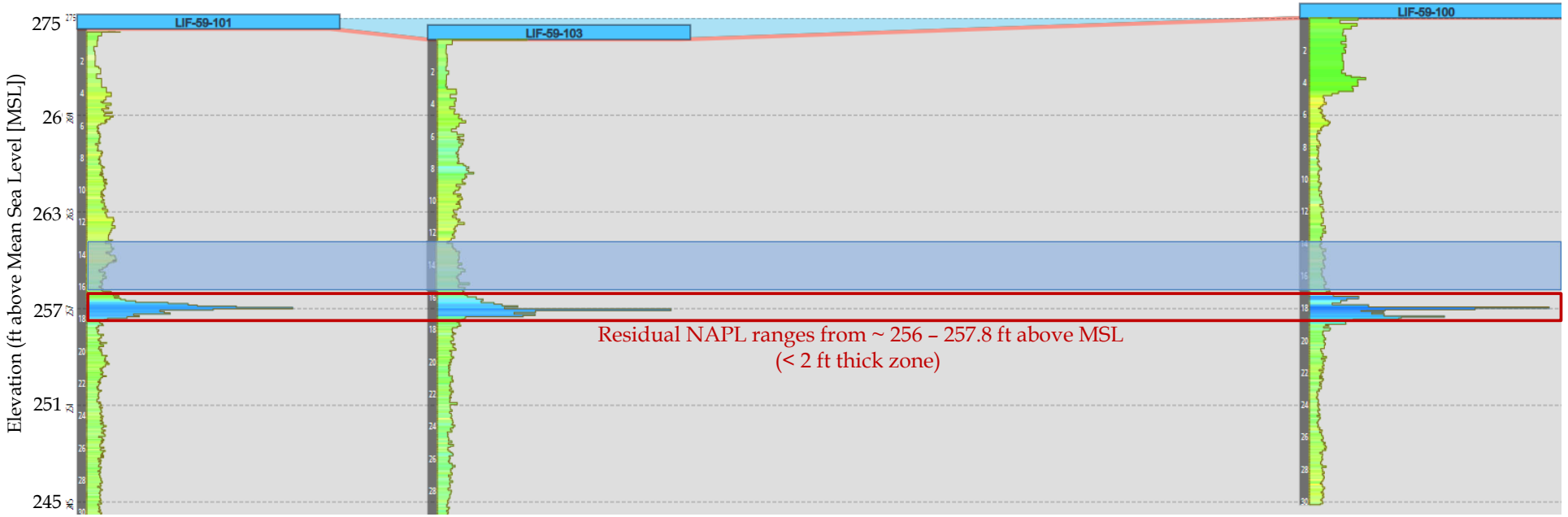
2018 LIF

Residual LNAPL appears to remain in isolated pockets
Residual LNAPL remains under the taxiway

Groundwater flow direction

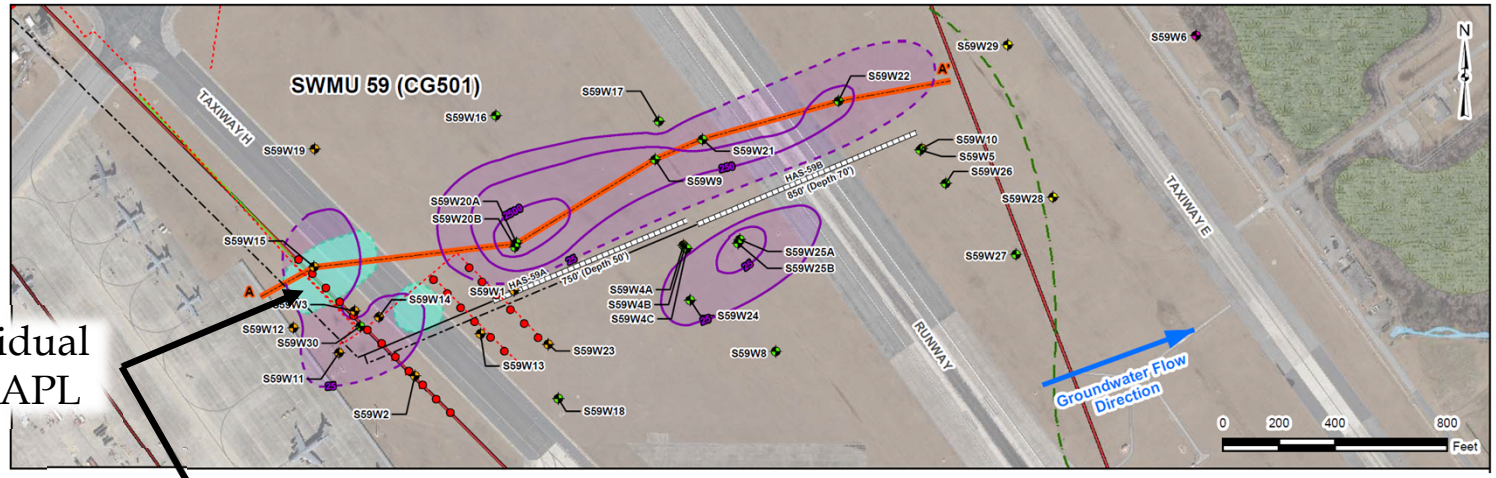
Site Investigations
(SWMU 59)

2018 SWMU 59
LIF Locations



SWMU 59 LIF Cross-section

Site Investigations
(SWMU 59)

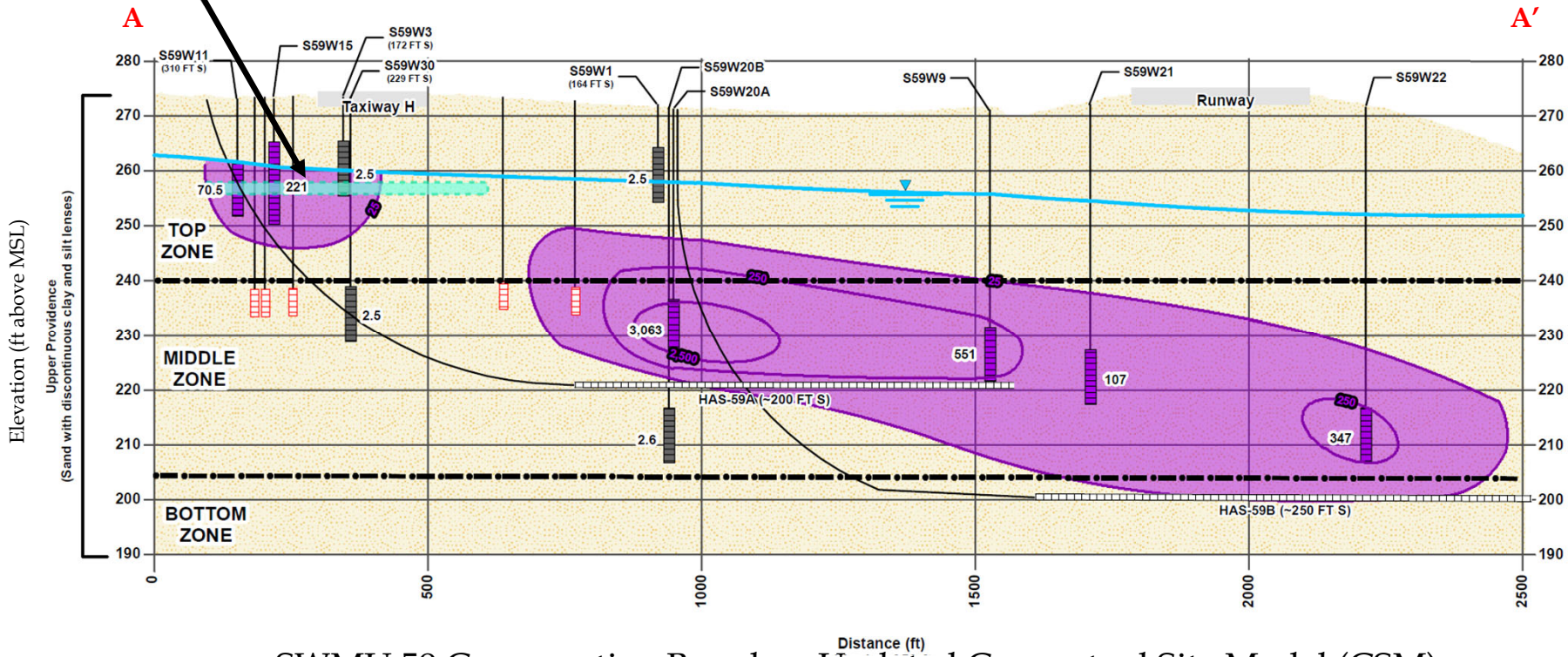


Residual LNAPL

Total COC Concentration Contour (µg/L; inferred where dashed)

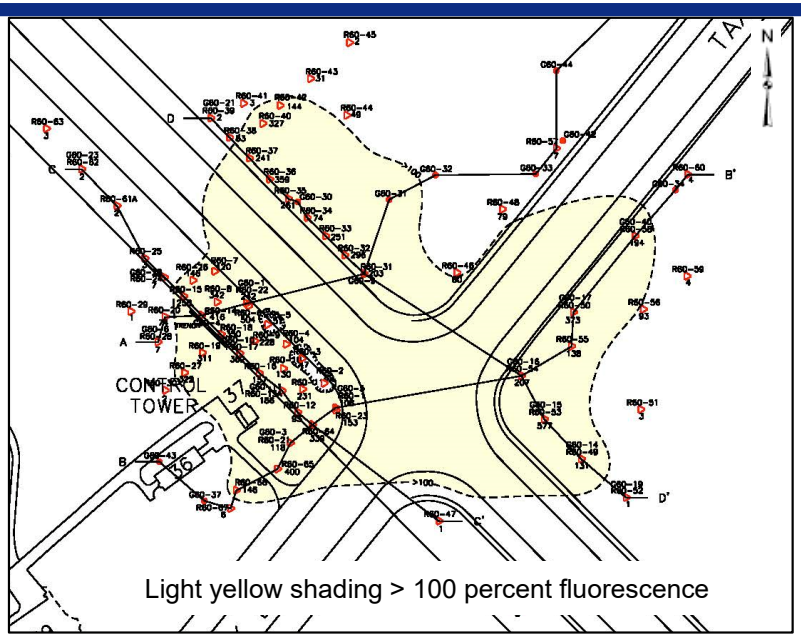
Total COC Extent > 25 µg/L

Approximate Extent of Residual LNAPL (based on 2018/2019 investigation)

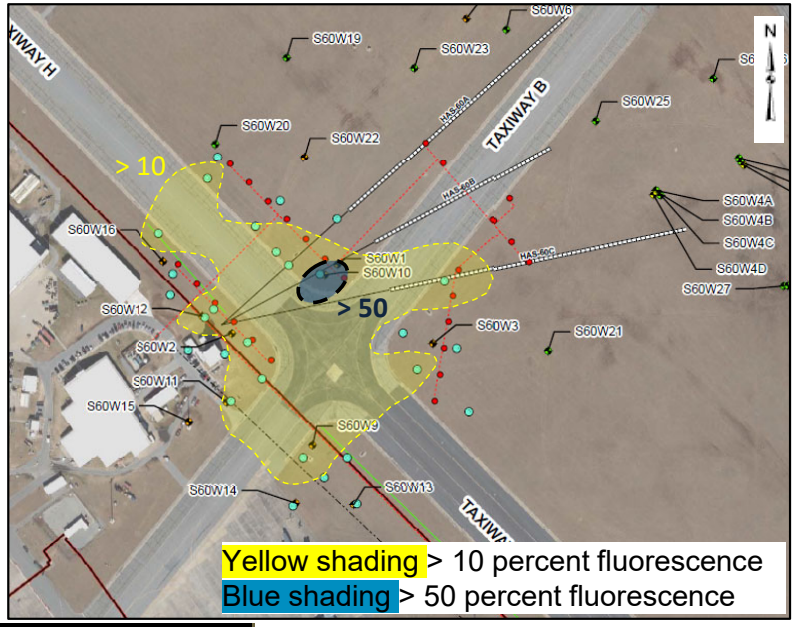


SWMU 59 Cross-section Based on Updated Conceptual Site Model (CSM)

Site Investigations
(SWMU 60)

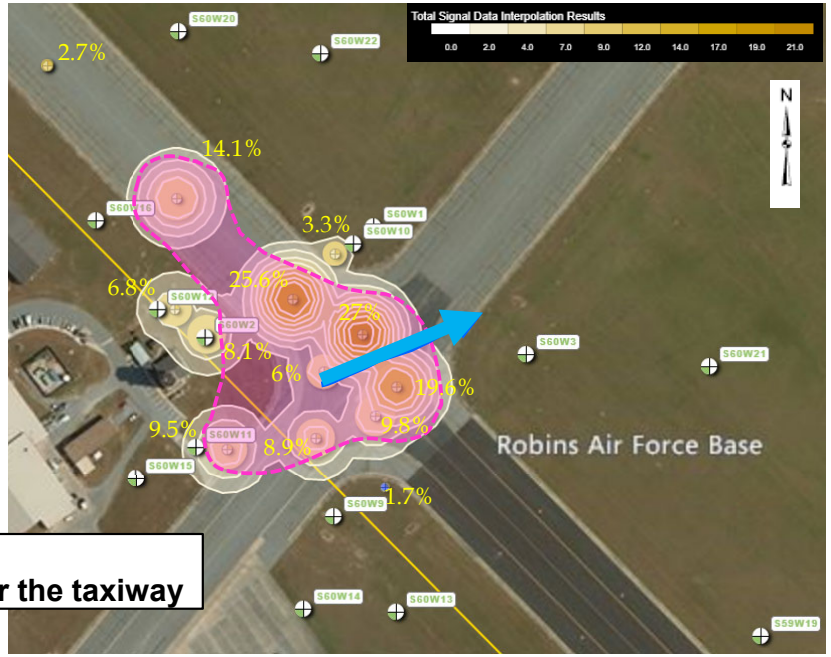


1997 ROST™



2014 LIF

2018 LIF

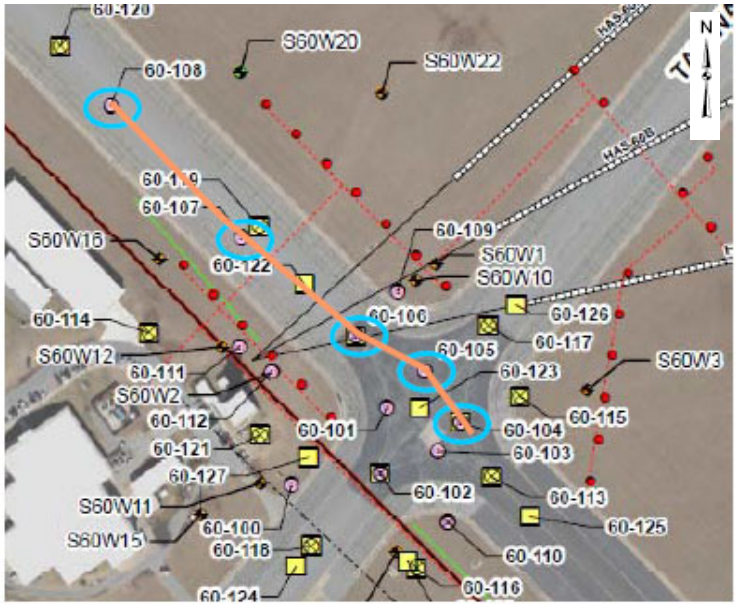


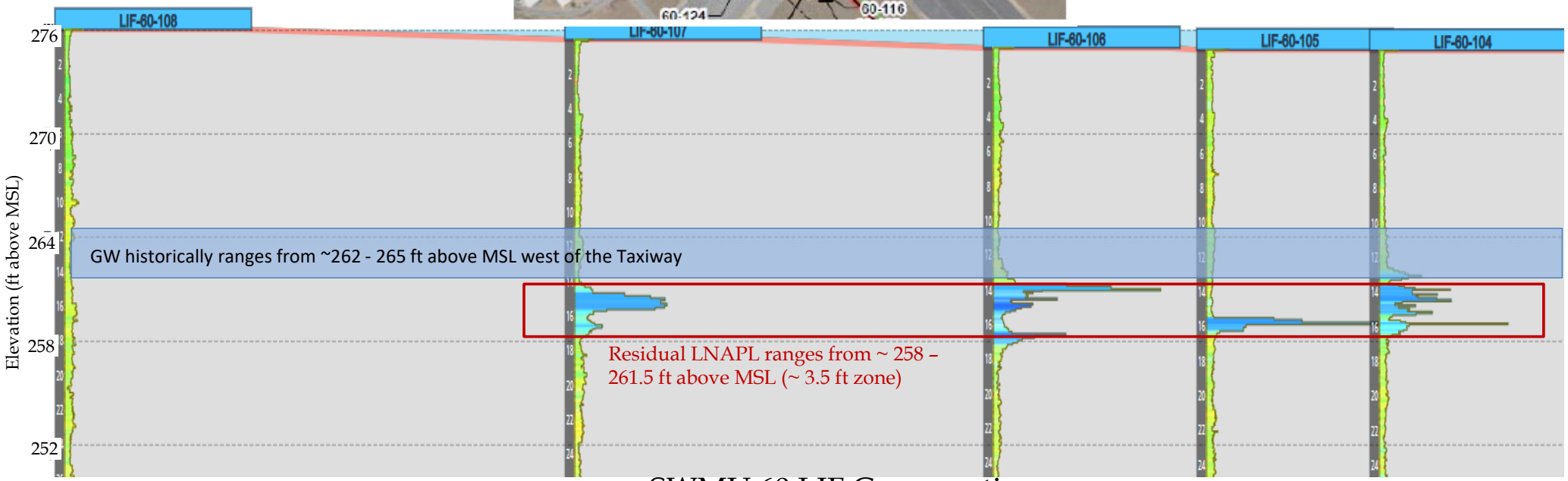
NAPL footprint has decreased
Residual LNAPL remains under the taxiway

Groundwater flow direction

Site Investigations
(SWMU 60)

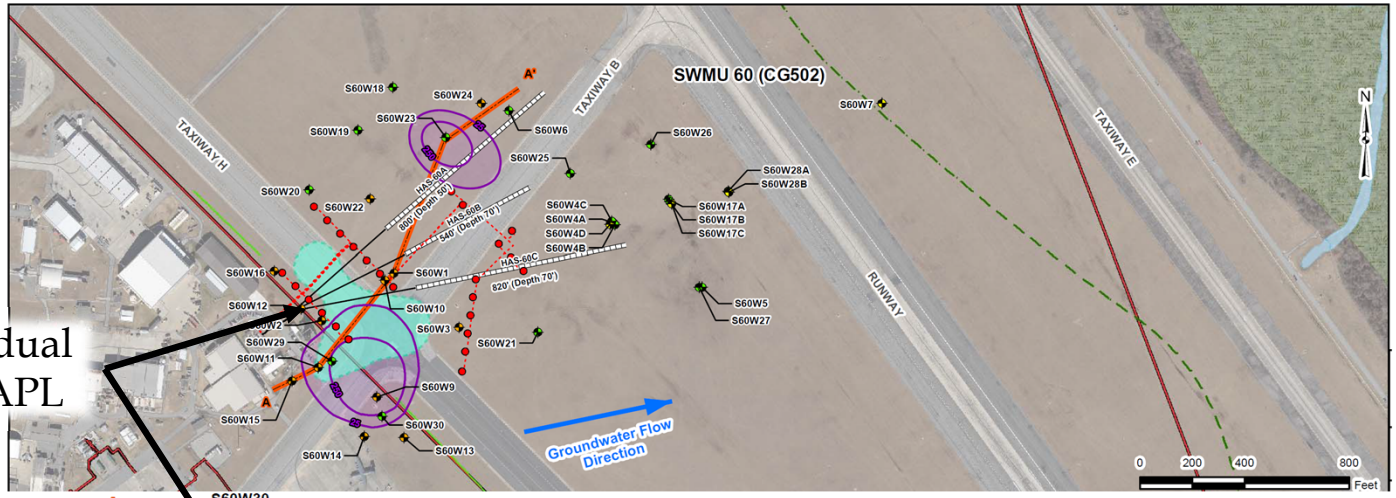
2018 SWMU 60
LIF Locations





SWMU 60 LIF Cross-section

Site Investigations
(SWMU 60)

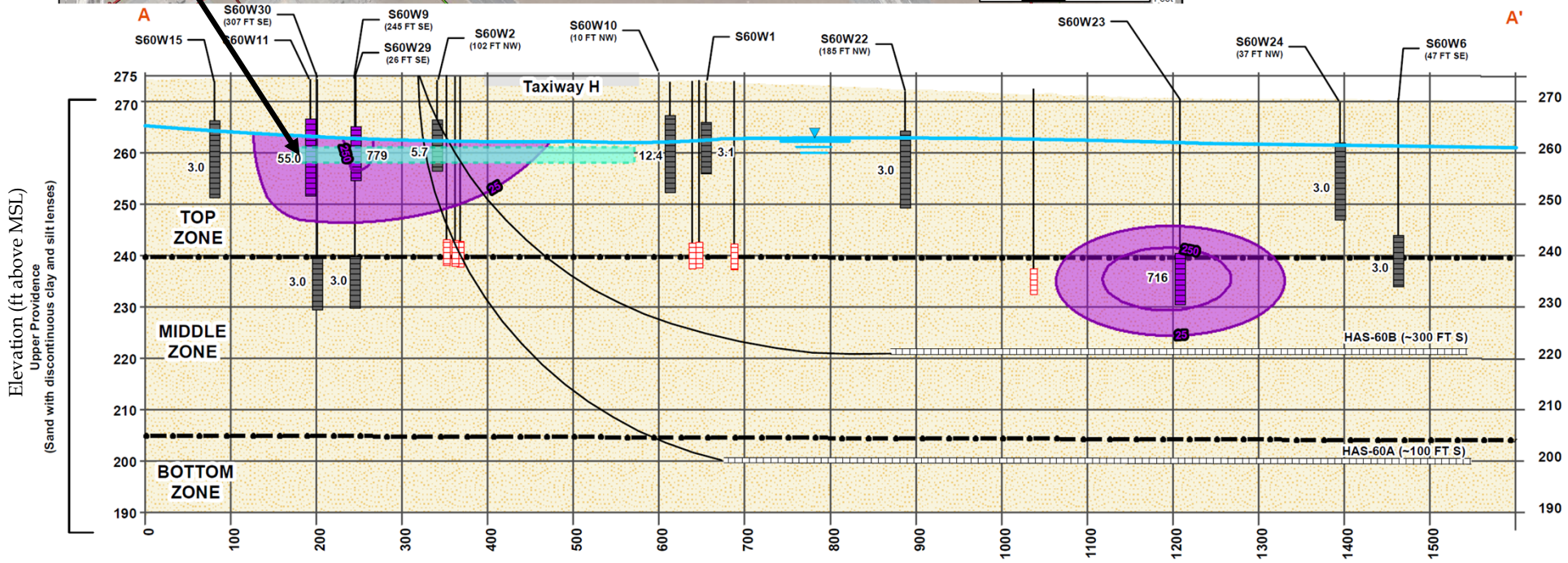


Residual LNAPL

Total COC Concentration Contour (µg/L; inferred where dashed)

Total COC Extent > 25 µg/L

Approximate Extent of Residual LNAPL (based on 2018/2019 investigation)



SWMU 60 Cross-section Based on Updated CSM

Site Investigations

- **Updates to Conceptual Site Model based on Source Area Investigation:**
  - Residual LNAPL identified
    - Beneath taxiway, near pipeline, and below water table
  - Residual LNAPL appears immobile and non-recoverable
  - Residual LNAPL is acting as ongoing source contributing to downgradient plume

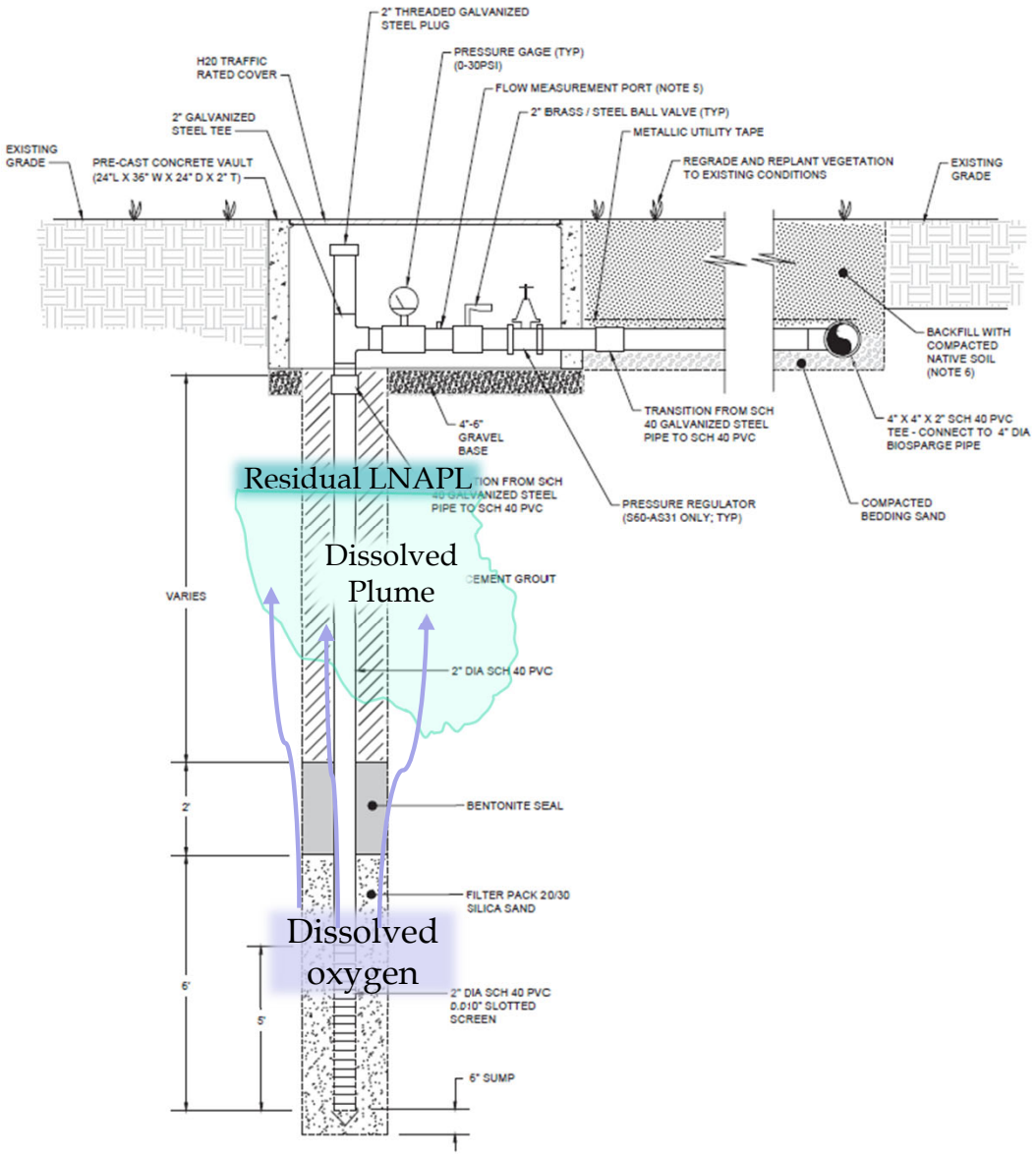
CAP Addendum

- **Current biosparge system has been shown to be effective within its zone of influence**
- **Enhance remedial approach to address source area**
- **CAP Addendum: updated approach to accelerate cleanup approved by Georgia Environmental Protection Division (GA EPD) in October 2021**
  - Expand biosparge system to target residual LNAPL under taxiways and in areas beyond current biosparge influence
  - Downgradient concentrations will attenuate

Remedial Design

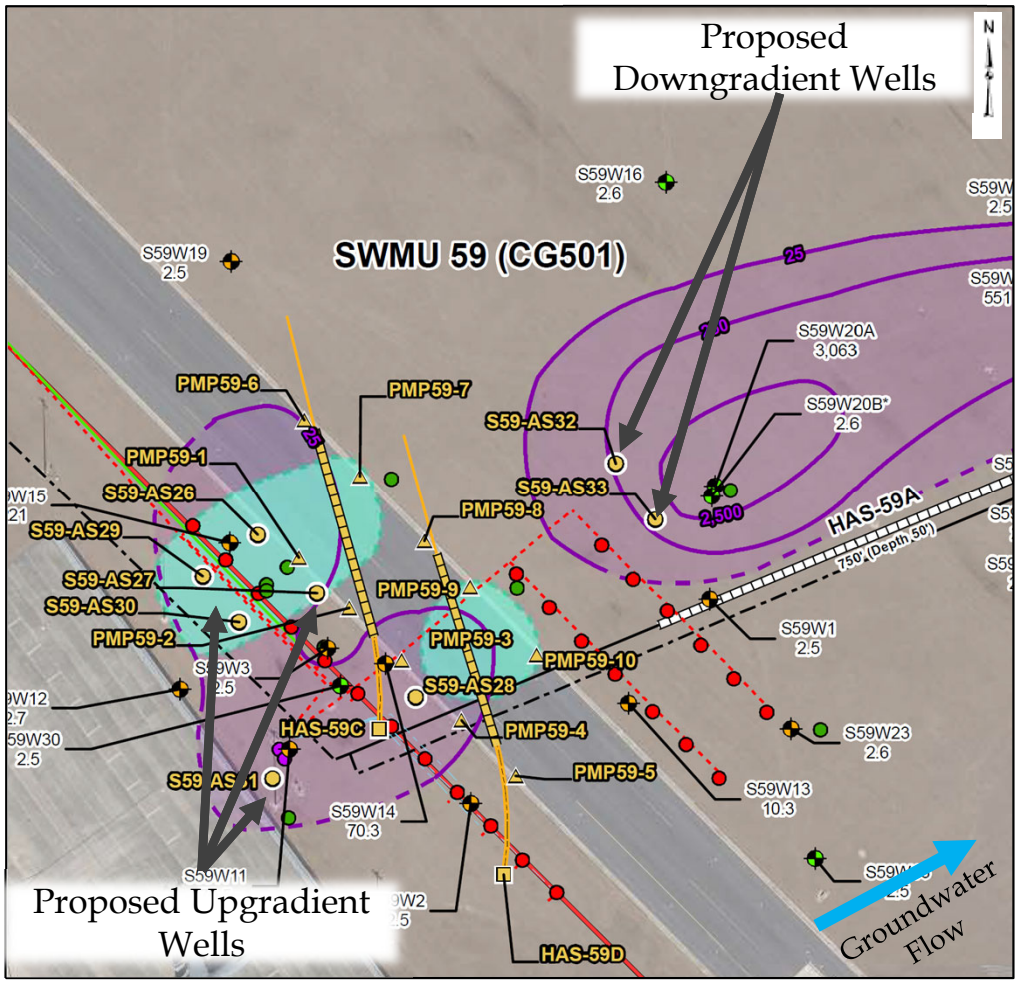
- **Remedial Design/Remedial (RD/RA) Work Plan planning documents submitted to GA EPD in June 2022**

- **System enhancements at each SWMU**
  - Six vertical biosparge wells to expand influence in upgradient areas
  - Two vertical biosparge wells to expand influence in downgradient areas

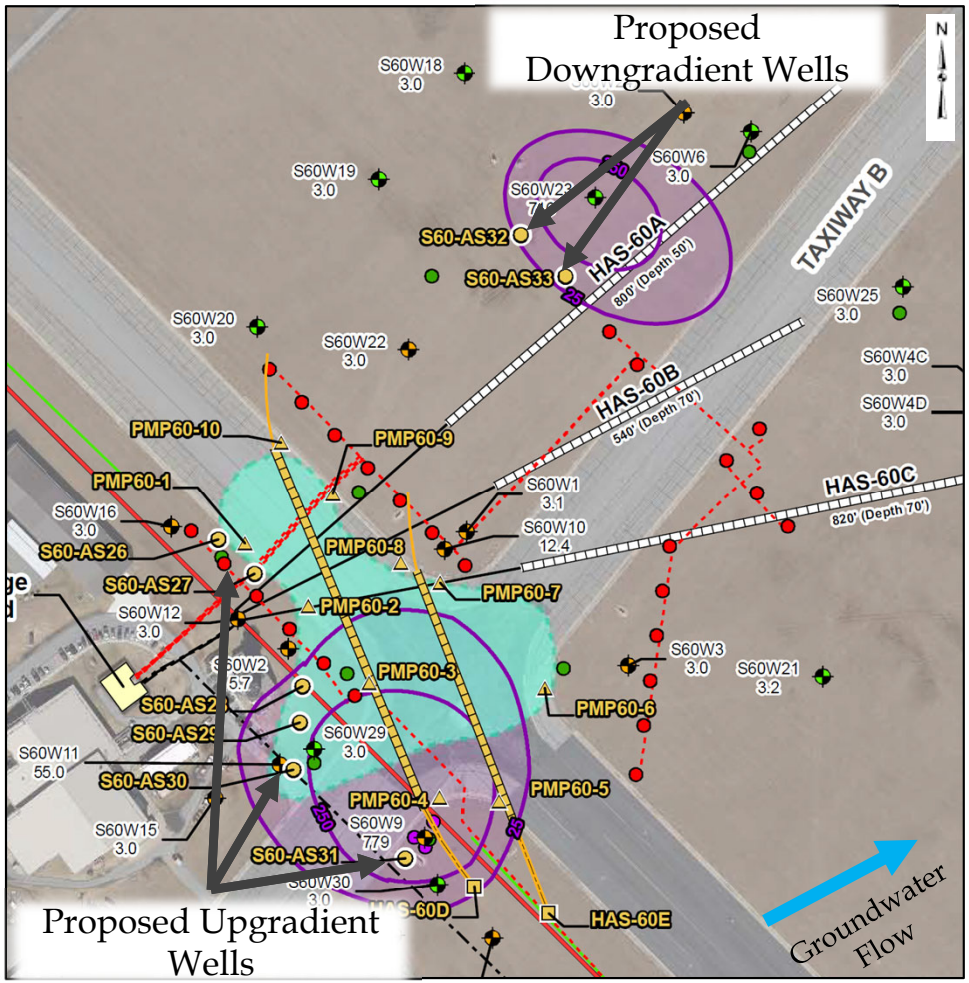


Proposed Vertical Biosparge Well

Remedial Design



Proposed SWMU 59 Remediation Enhancements

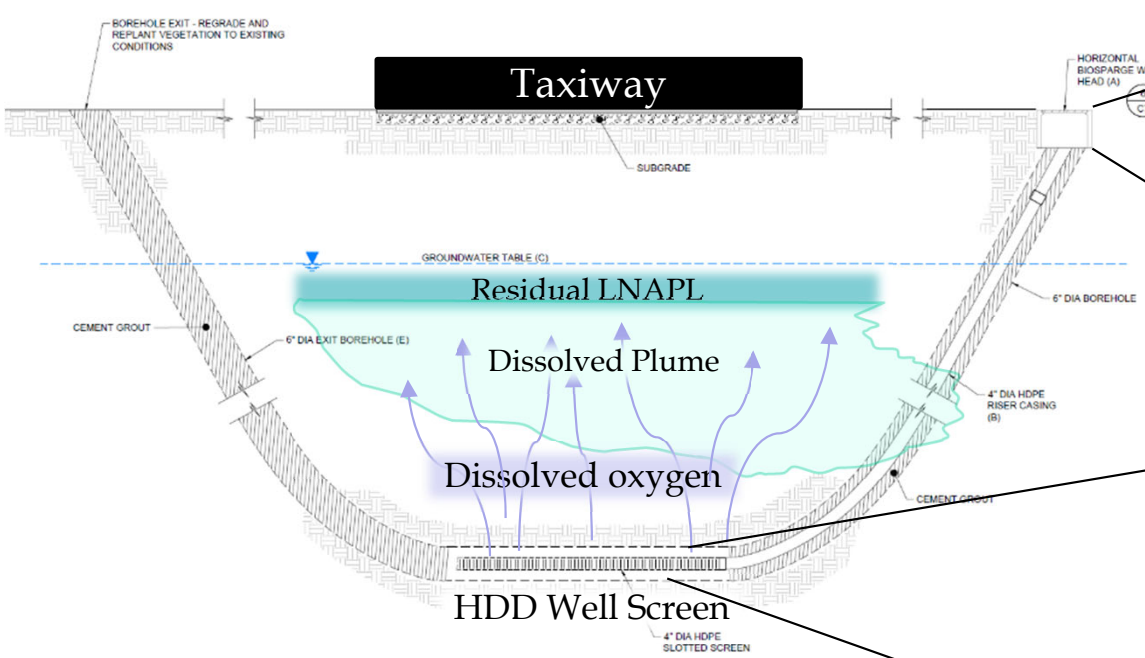


Proposed SWMU 60 Remediation Enhancements

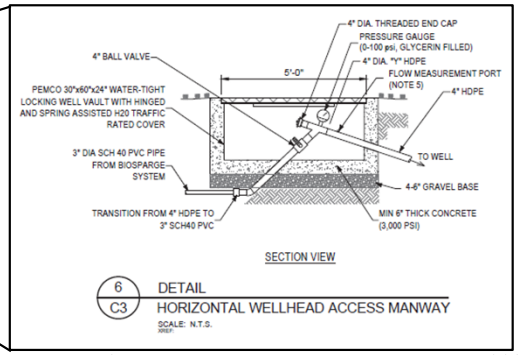
Existing System:	**Proposed System Enhancements:**
Vertical Biosparge Well	Proposed Vertical Biosparge Well
HDD Bioparge Well	Proposed HDD Biosparge Well
iSOC® Well	Proposed Pressure Monitoring Point

Remedial Design

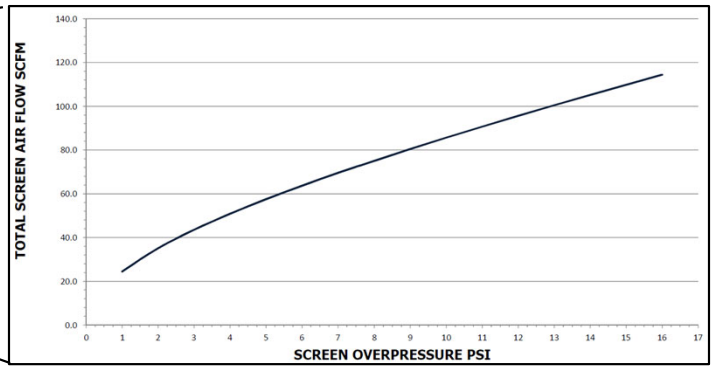
- **System enhancements at each SWMU:**
  - Two HDD biosparge wells to address areas underneath taxiway
  - Custom well screens designed to provide uniform air distribution



Proposed HDD Biosparge Well Cross-section

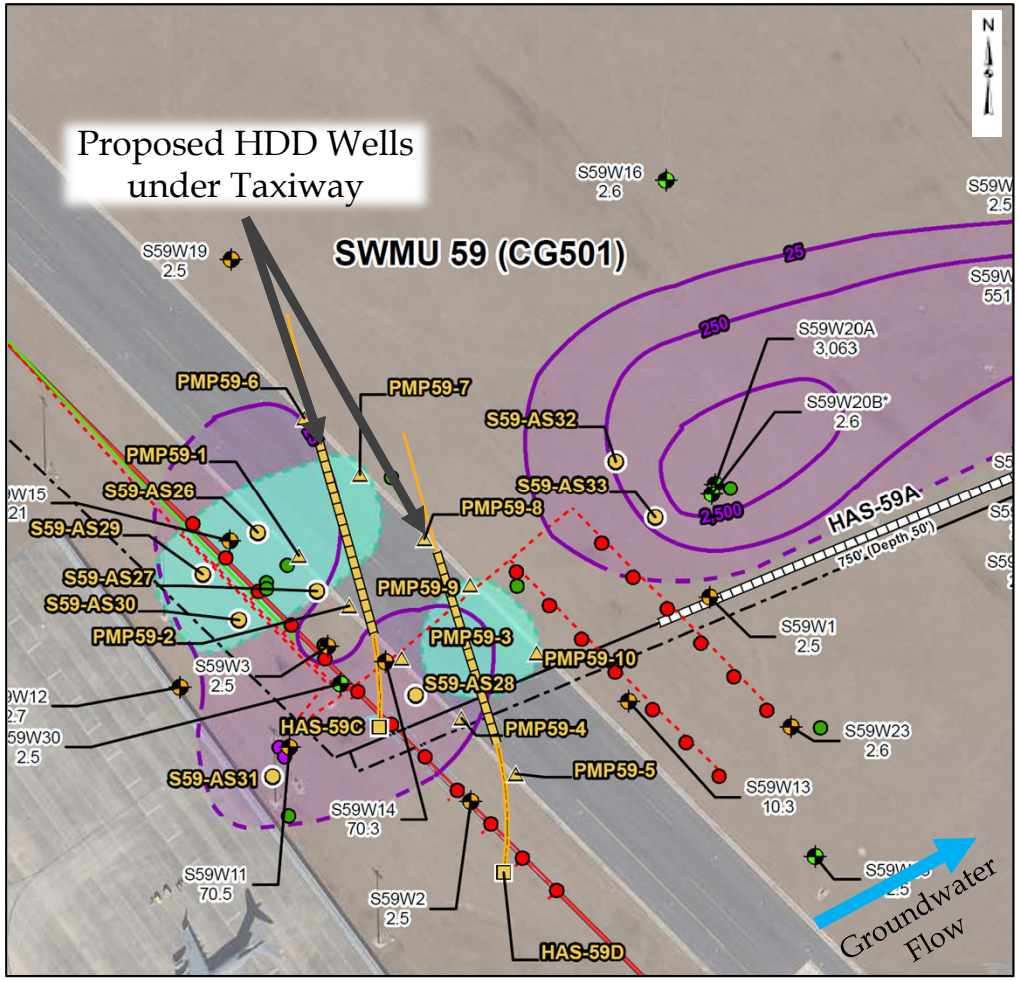


Proposed HDD Biosparge Wellhead with Instrumentation

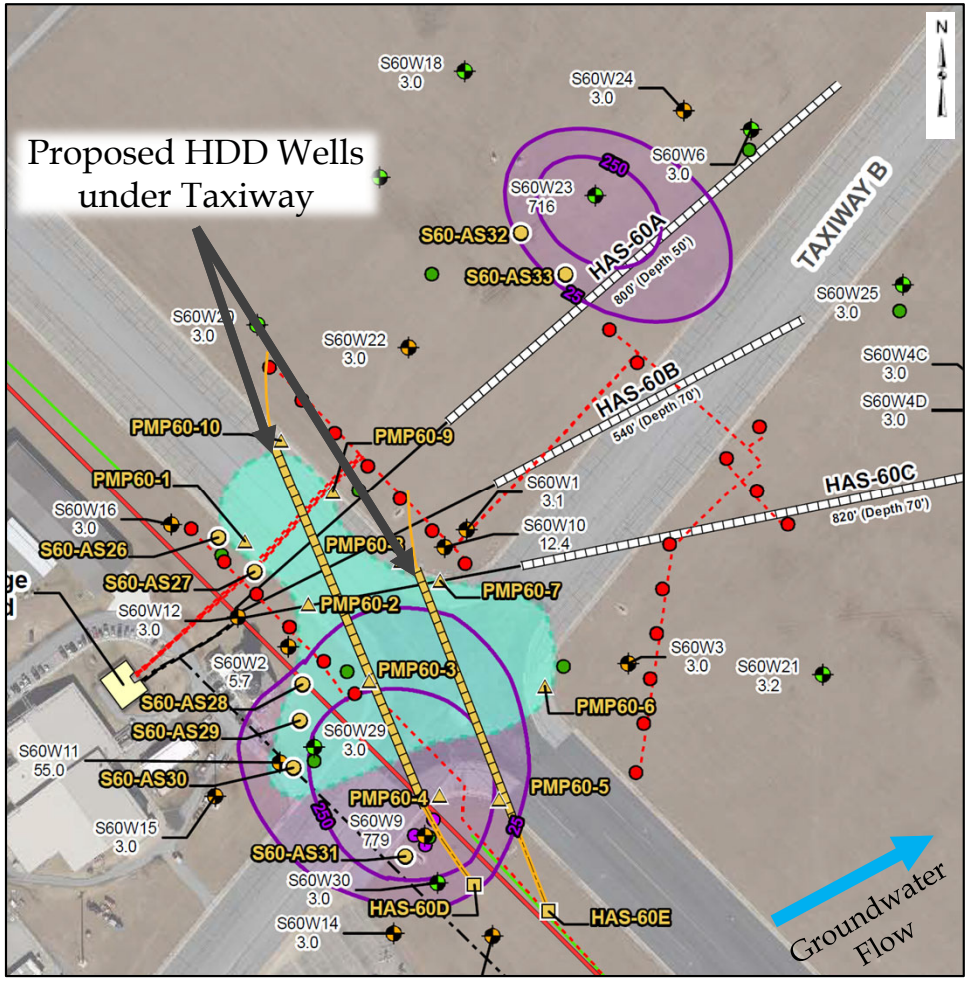


Predicted Air Flowrate based on Air Pressure Applied at Wellhead

Remedial Design



Proposed SWMU 59 Remediation Enhancements



Proposed SWMU 60 Remediation Enhancements

Existing System:	Proposed System Enhancements:
Vertical Biosparge Well	Proposed Vertical Biosparge Well
HDD Bioparge Well	Proposed HDD Biosparge Well
iSOC® Well	Proposed Pressure Monitoring Point

Path Forward

- **Tentative Quarter 1 (Q1)/Q2 2023: Construction of biosparge expansion**
- **Tentative Summer 2023: Biosparging with expanded system components**

HDD Drill Rig at SWMU 59 in 2012

HDD Installation at SWMU 59 in 2012

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Questions?

SWMU 62 (OT037) – Update on Progress

Elizabeth Rhine
Technical Lead
Bhate

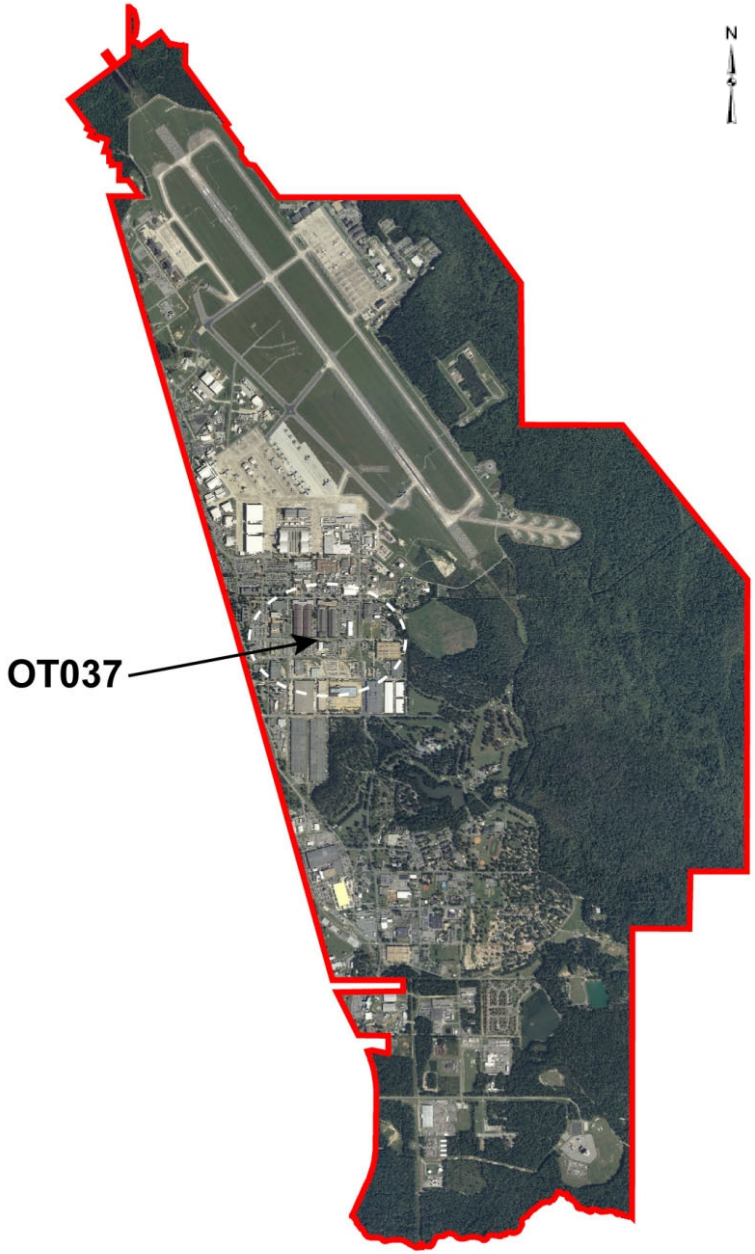
August 4, 2022

Overview

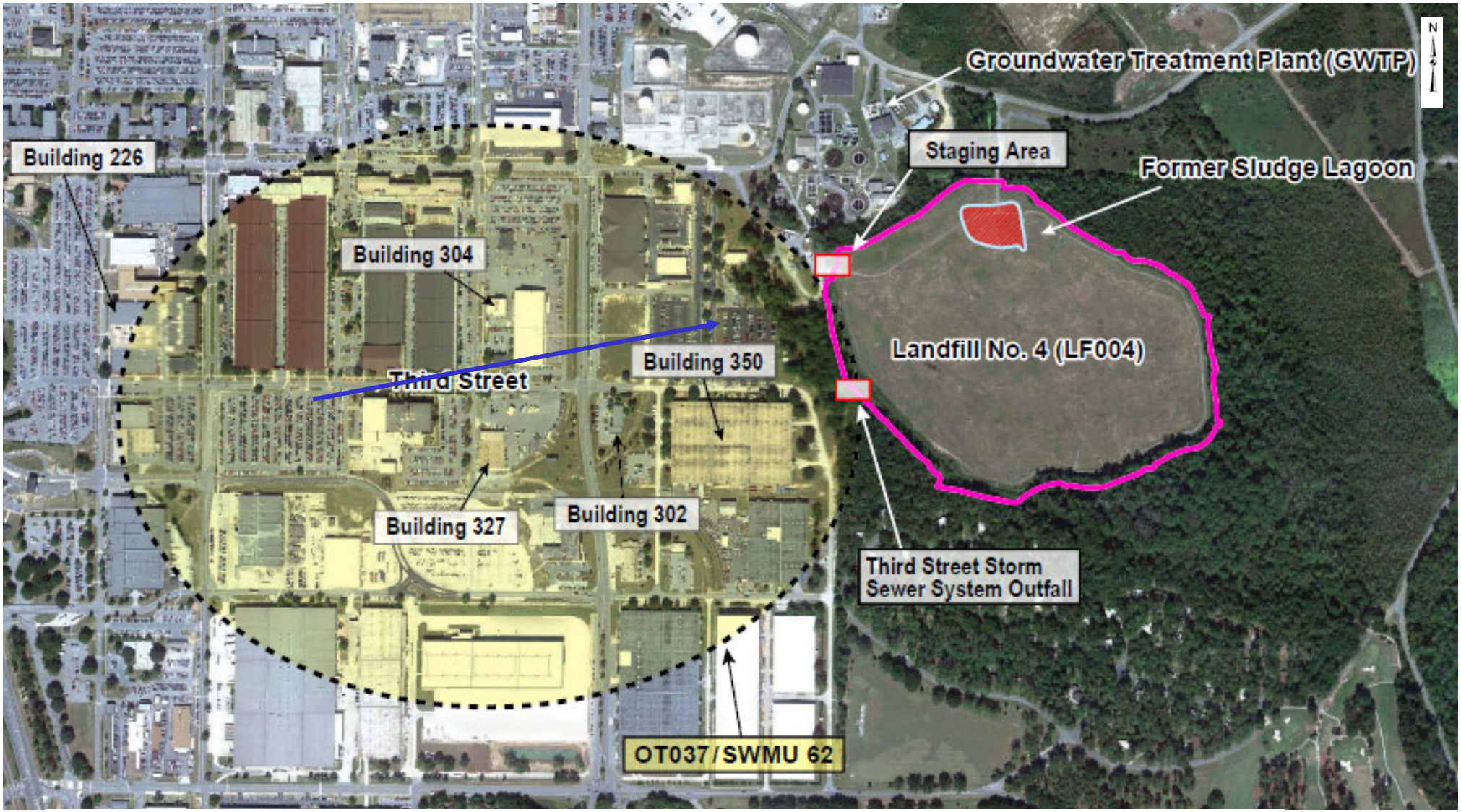
- Background
- Site location
- Remediation history
- Data gap investigation
- Next steps
- Path forward

Background

- Primary contaminants of concern in groundwater are tetrachloroethene (PCE), trichloethene (TCE), and carbon tetrachloride (CT)
- Originally identified in 1990, groundwater plume was associated with 48-inch storm sewer outfall (Third Street outfall)
- Resource Conservation and Recovery Act (RCRA) Facility Investigation conducted by RUST/Earth Tech in 1999
  - Sewer testing did not support sewer as source
  - Highest TCE concentrations are on northwest side of Building 350 near water table
  - Source area not confirmed
  - Unsaturated soil not identified as concern



Site Location



Remediation History

TCE Plume (May 1999)

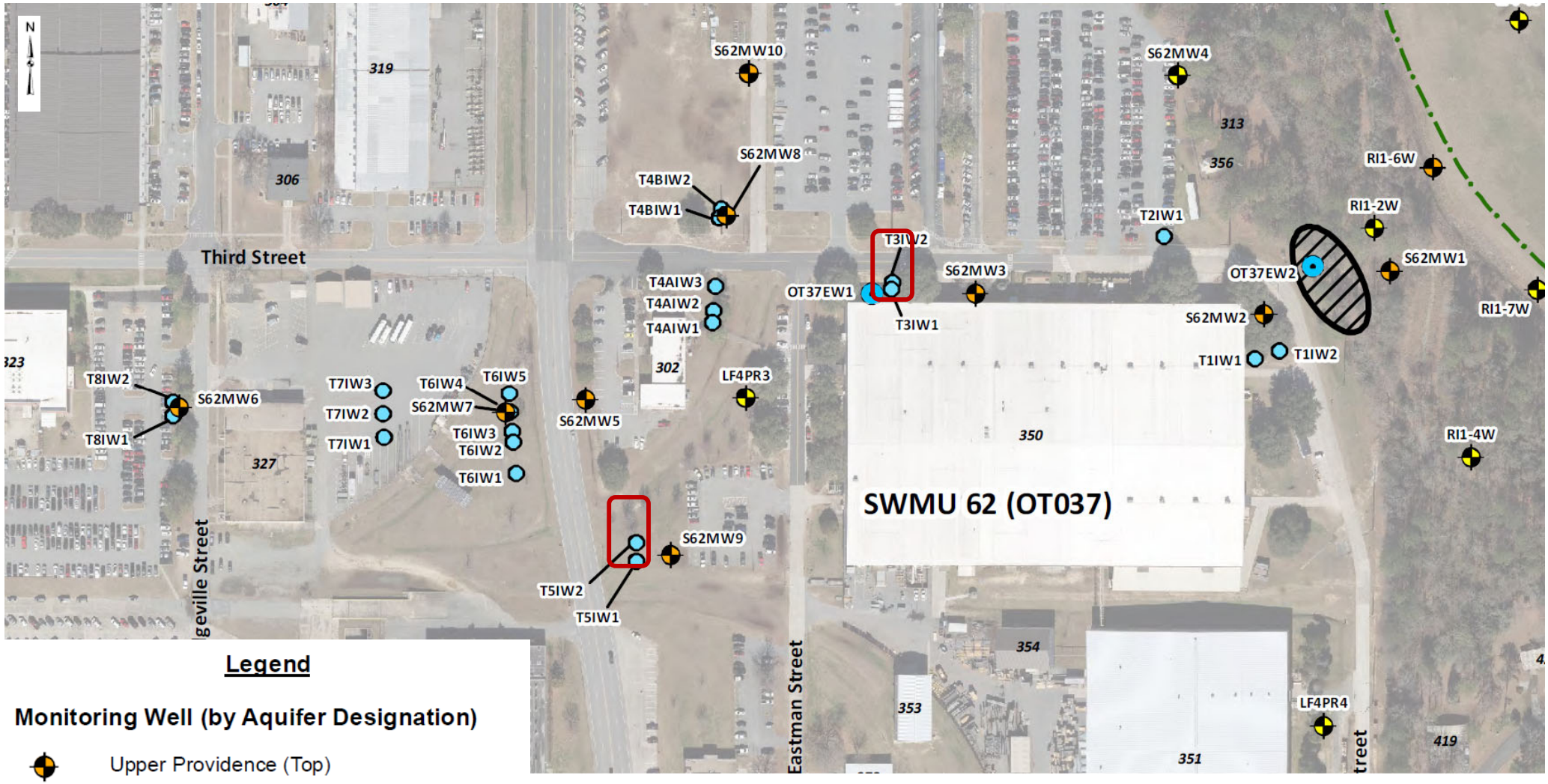
* Pumping initiated 2002; shown on figure for reference purposes only

Remediation History
Prior Remedial Actions

- **2002 Corrective Action Plan (CAP) – Pump & Treat**
  - Two recovery wells put into service in early 2002
  - EW1 taken offline in April 2009 due to low productivity
  - EW2 shut down in August 2013 due to asymptotic removal rates
- **2012 Revised CAP: In Situ Chemical Oxidation (ISCO) using potassium permanganate ($KMnO_4$)**
  - 2013: 240,000 gallons $KMnO_4$ via 22 injection wells
  - 2016: 60,000 gallons $KMnO_4$ via 4 injection wells
  - 2017: 40,000 gallons $KMnO_4$ via 10 direct push technology (DPT) temporary points

Remediation History

Locations of Injection Points



Legend

Monitoring Well (by Aquifer Designation)

- Upper Providence (Top)
- Upper Providence (Bottom)
- Extraction Well (Inactive)
- Injection Well (2013)

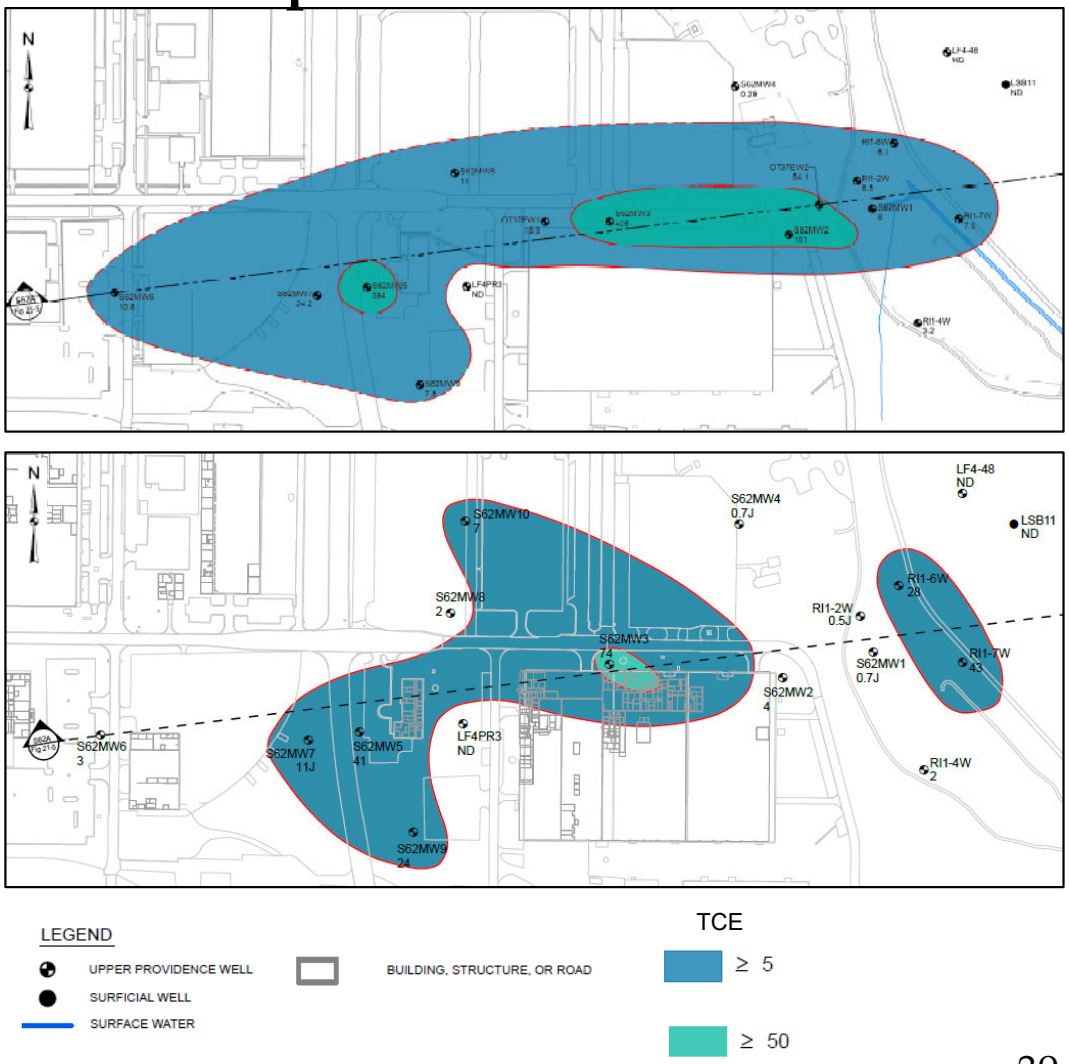
Re-Injection (2016)

Approximate Location of 10 DPT Injection Locations (2017)

Remediation History
Progress using $KMnO_4$

- **Overall remediation progress from 2013 to 2019**
  - **Average PCE concentration reduced by 70 percent**
  - **Average TCE concentration reduced by 85 percent**
  - **Average CT concentration reduced by 70 percent**
    - CT cannot be oxidized
    - Flushing/dilution or other attenuation process
  - **Chromium increased but currently has decreasing trend**

TCE plume from 2013 to 2019



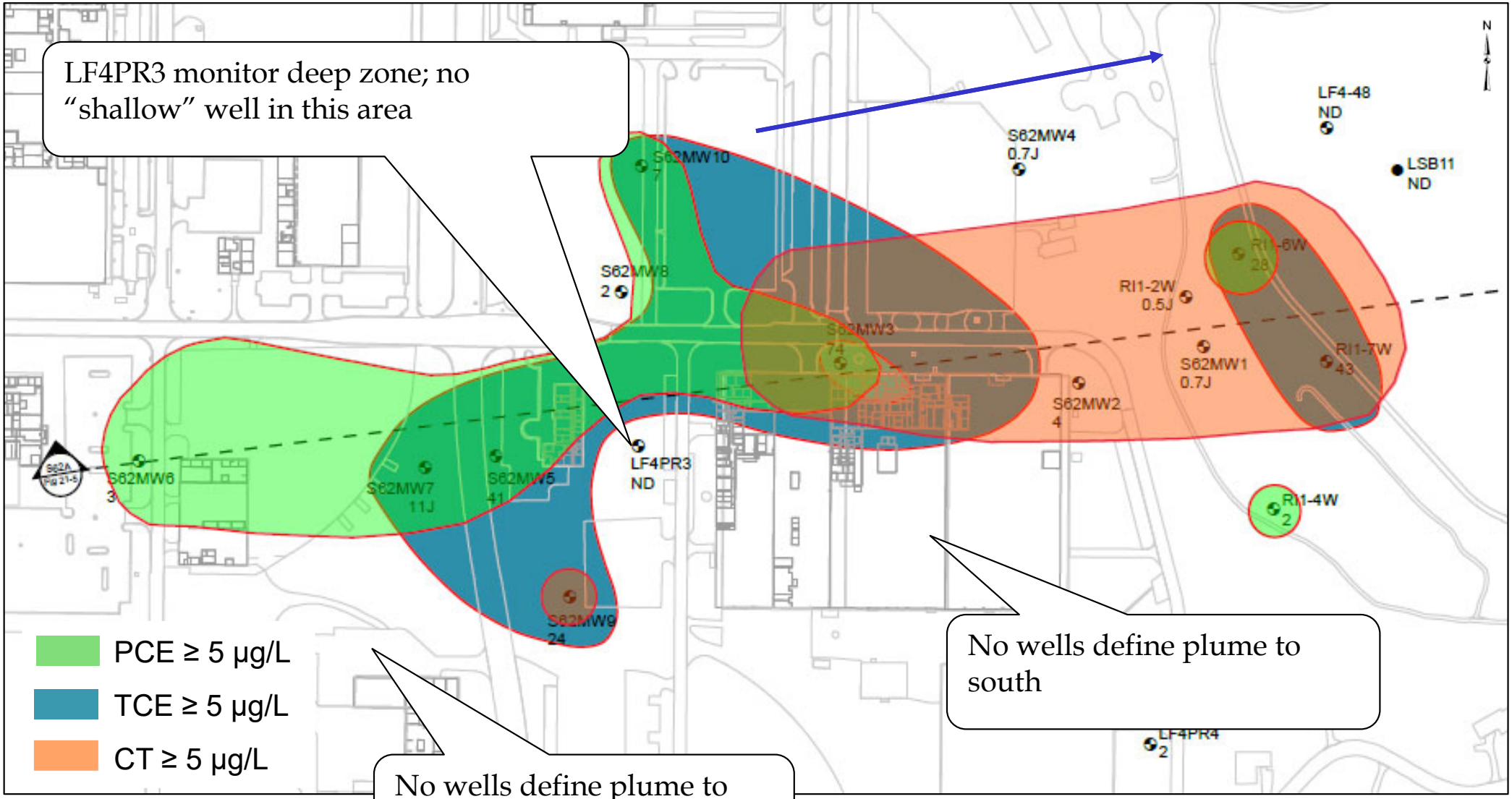
Remediation History

Optimized Remediation Contract (ORC) Award

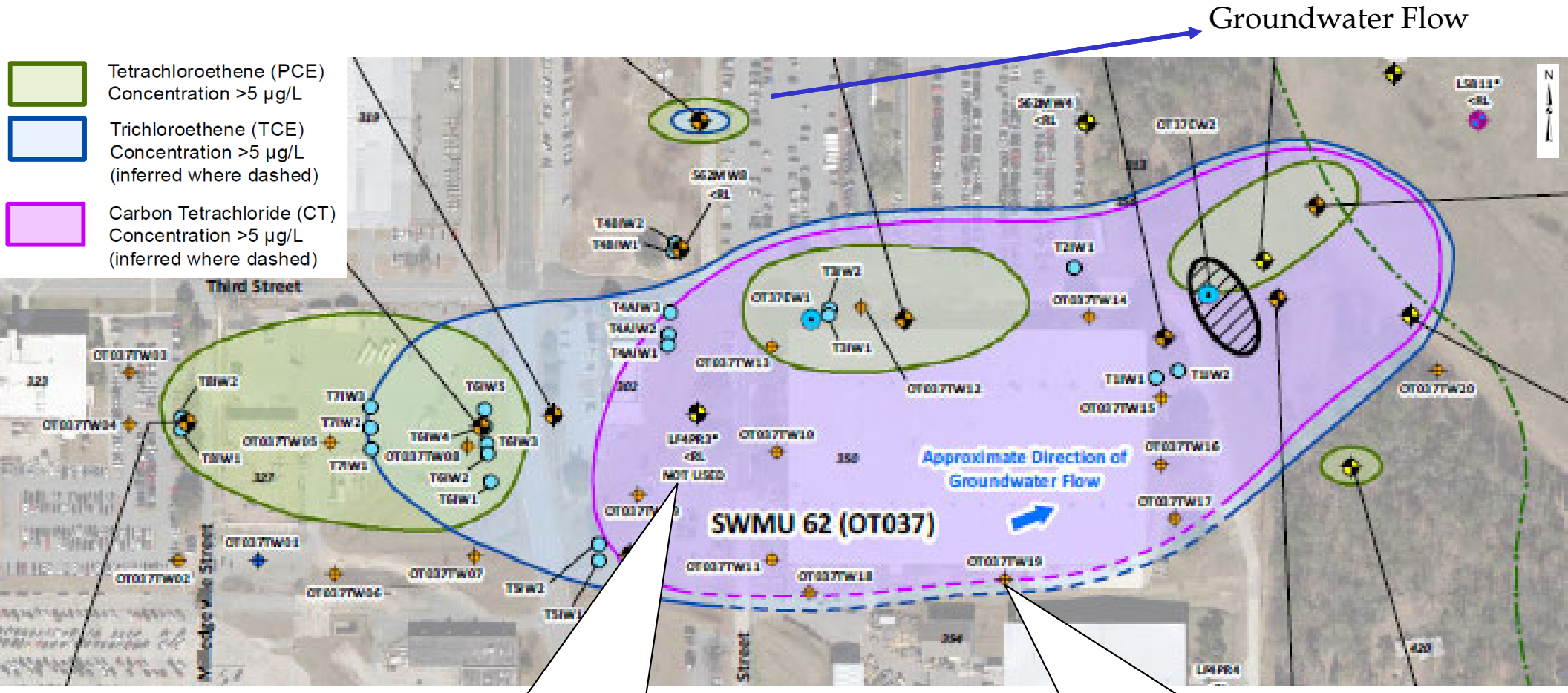
- **Performance Objectives:**
  - Achieve Remediation Levels (RLs) by end of contract (September 2027)
  - PCE, TCE, and CT below 5 micrograms per liter (µg/L) in all wells
- **Not on target to achieve RLs at several well locations**
  - Concentrations have increased due to back diffusion from untreated areas
- **CT was not addressed by selected ISCO amendment**
  - Recognize limitations of $KMnO_4$
  - Recognize benefits of Modified Fenton's Reagent (MFR)
- **Insufficient data to optimize ISCO design**

Data Gap Investigation

Data Gaps as of April 2019



Data Gap Investigation
March 2020 Plume Interpretation

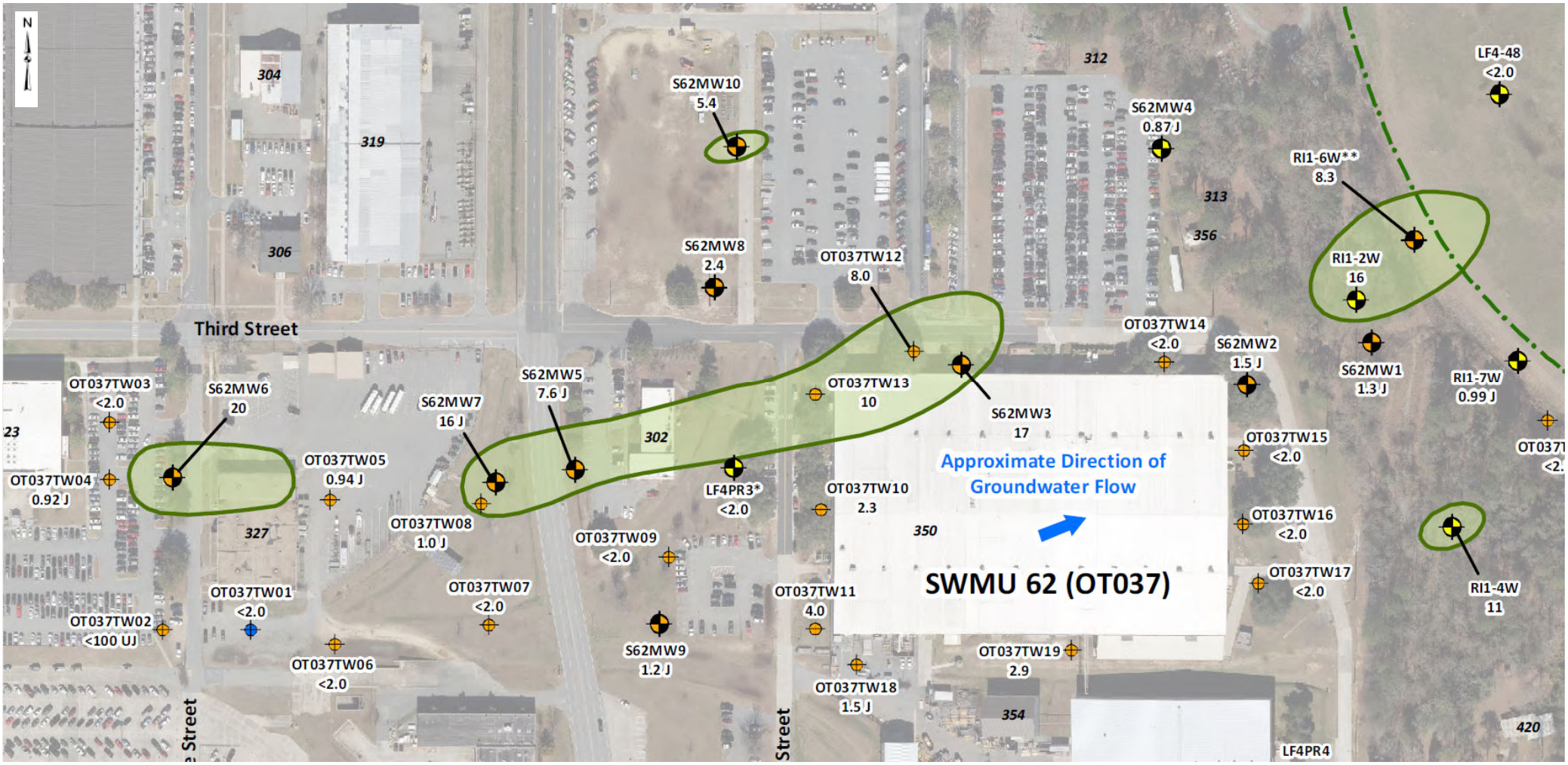


Data gap investigation wells proposed just below water table at LF4PR3

Data gap investigation wells proposed to define southern edge of plume

Data Gap Investigation

Results – March/September 2021 PCE Plume



S62MW3
17

Monitoring Well Identification

Concentration (µg/L)

Tetrachloroethene (PCE)
Concentration >5 µg/L

Upper Providence (Top)

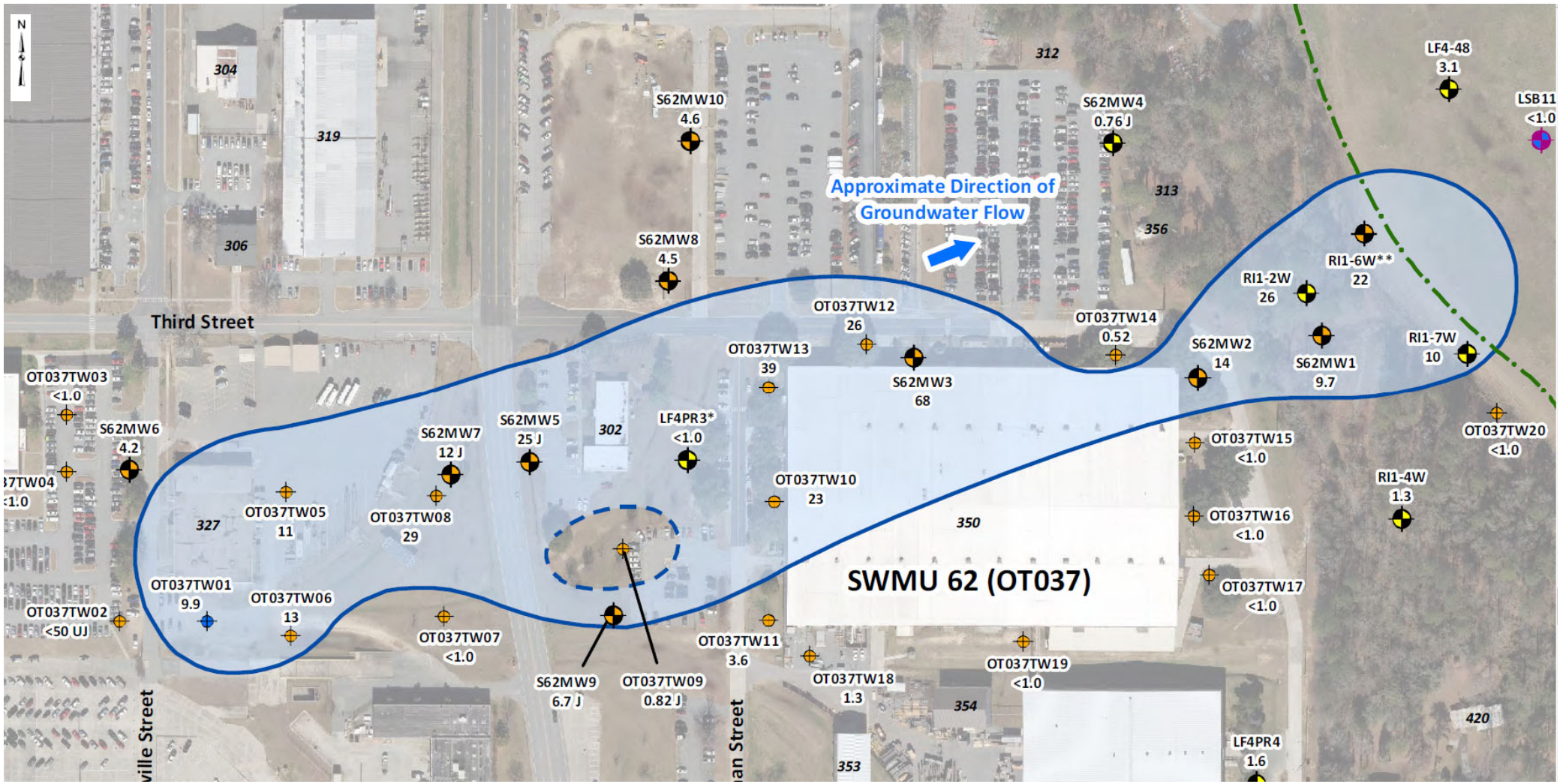
Upper Providence (Bottom)

DPT Grab Groundwater Sample

Temporary Upper Providence Well (Top)

Data Gap Investigation

Results – March/September 2021 TCE Plume



S62MW3 68 — Monitoring Well Identification / Concentration (µg/L)

Trichloroethene (TCE) Concentration >5 µg/L (inferred where dashed)

Upper Providence (Top)

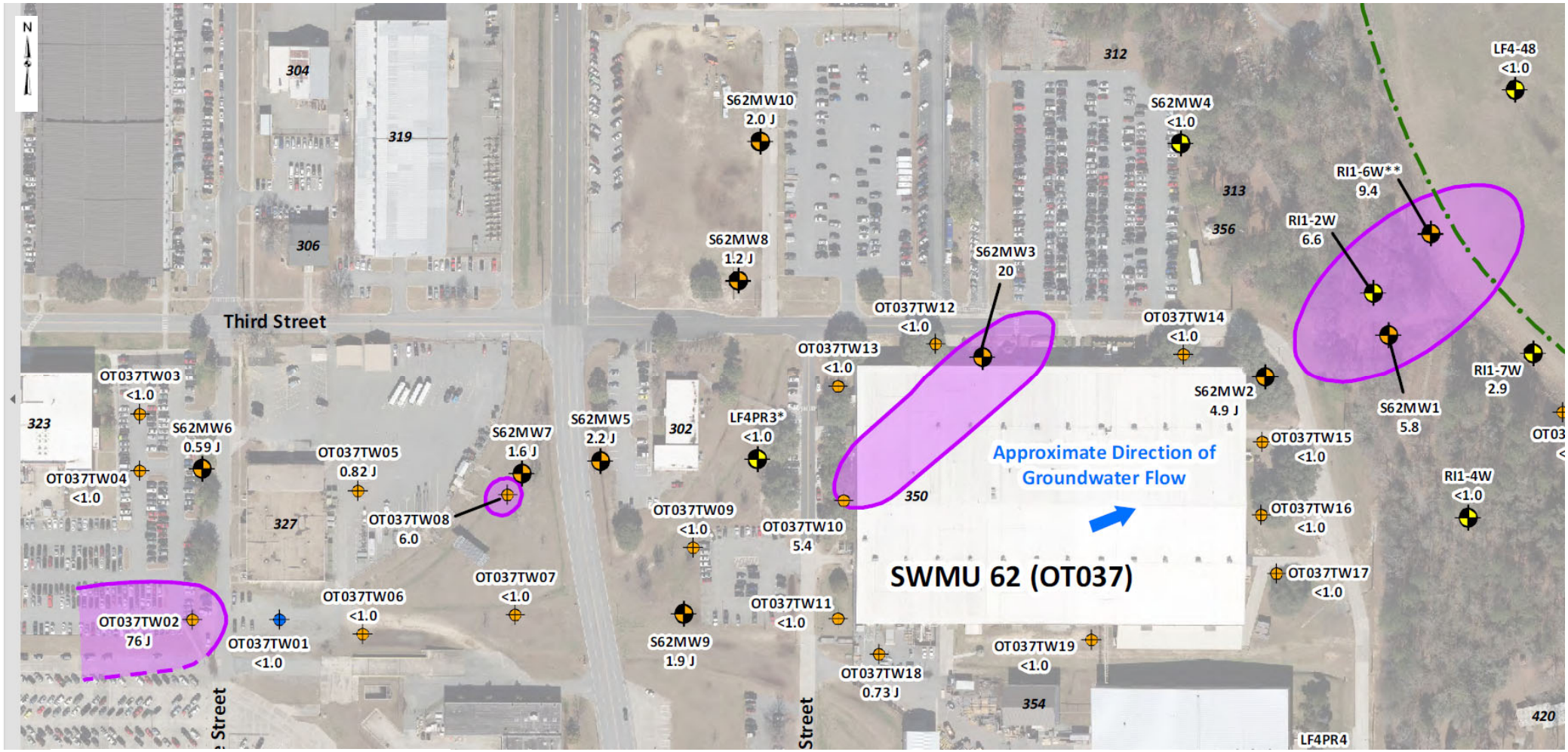
Upper Providence (Bottom)

DPT Grab Groundwater Sample

Temporary Upper Providence Well (Top)

Data Gap Investigation

Results – March/September 2021 CT Plume



S62MW3
20

Monitoring Well Identification

Concentration (µg/L)

Carbon Tetrachloride (CT)
Concentration >5 µg/L
(inferred where dashed)

Upper Providence (Top)

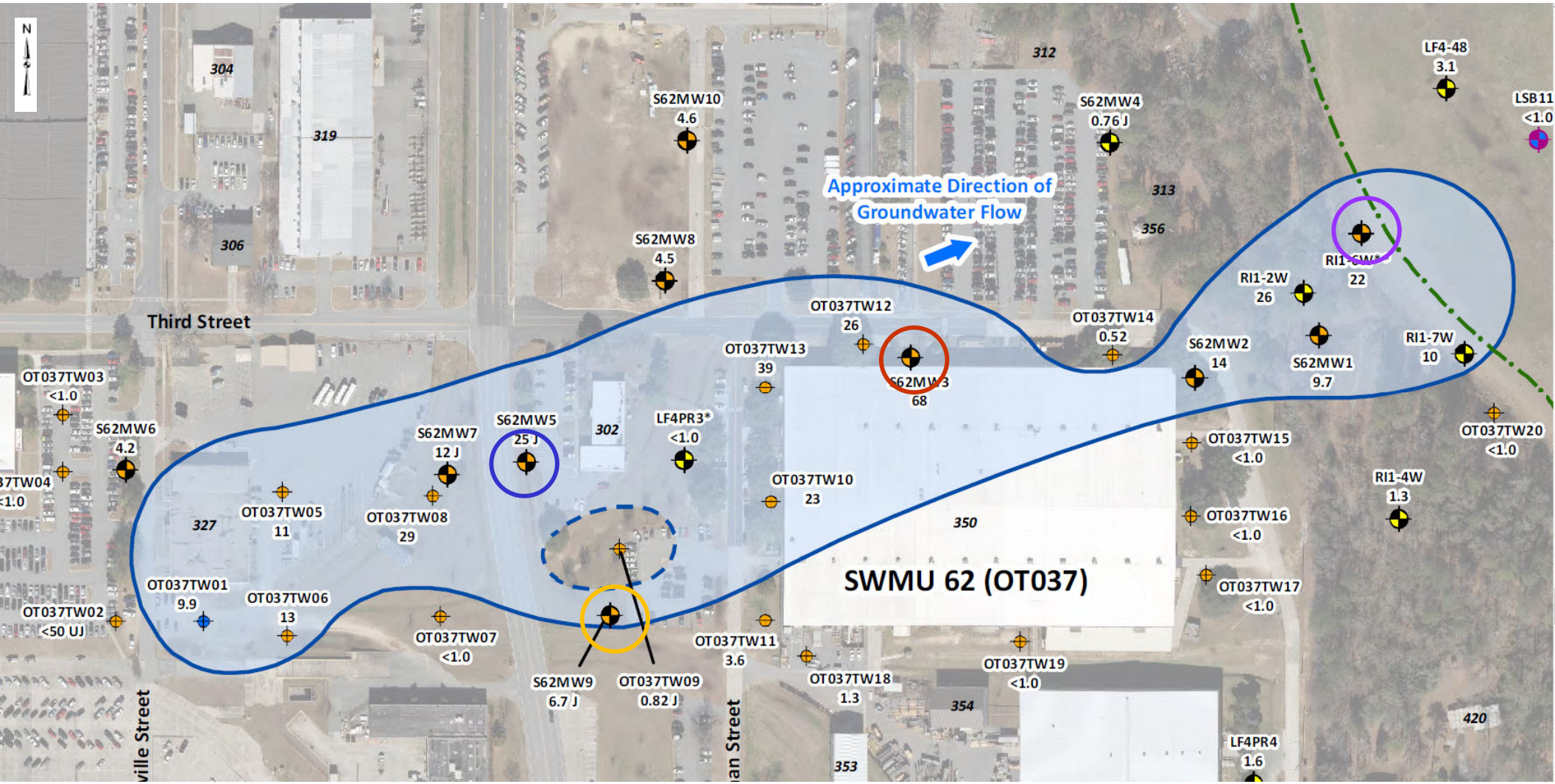
Upper Providence (Bottom)

DPT Grab Groundwater Sample

Temporary Upper Providence Well (Top)

Data Gap Investigation

TCE Concentration Trends – Well Locations



S62MW3 68 — Monitoring Well Identification; Concentration (µg/L)

Trichloroethene (TCE) Concentration >5 µg/L (inferred where dashed)

Upper Providence (Top)

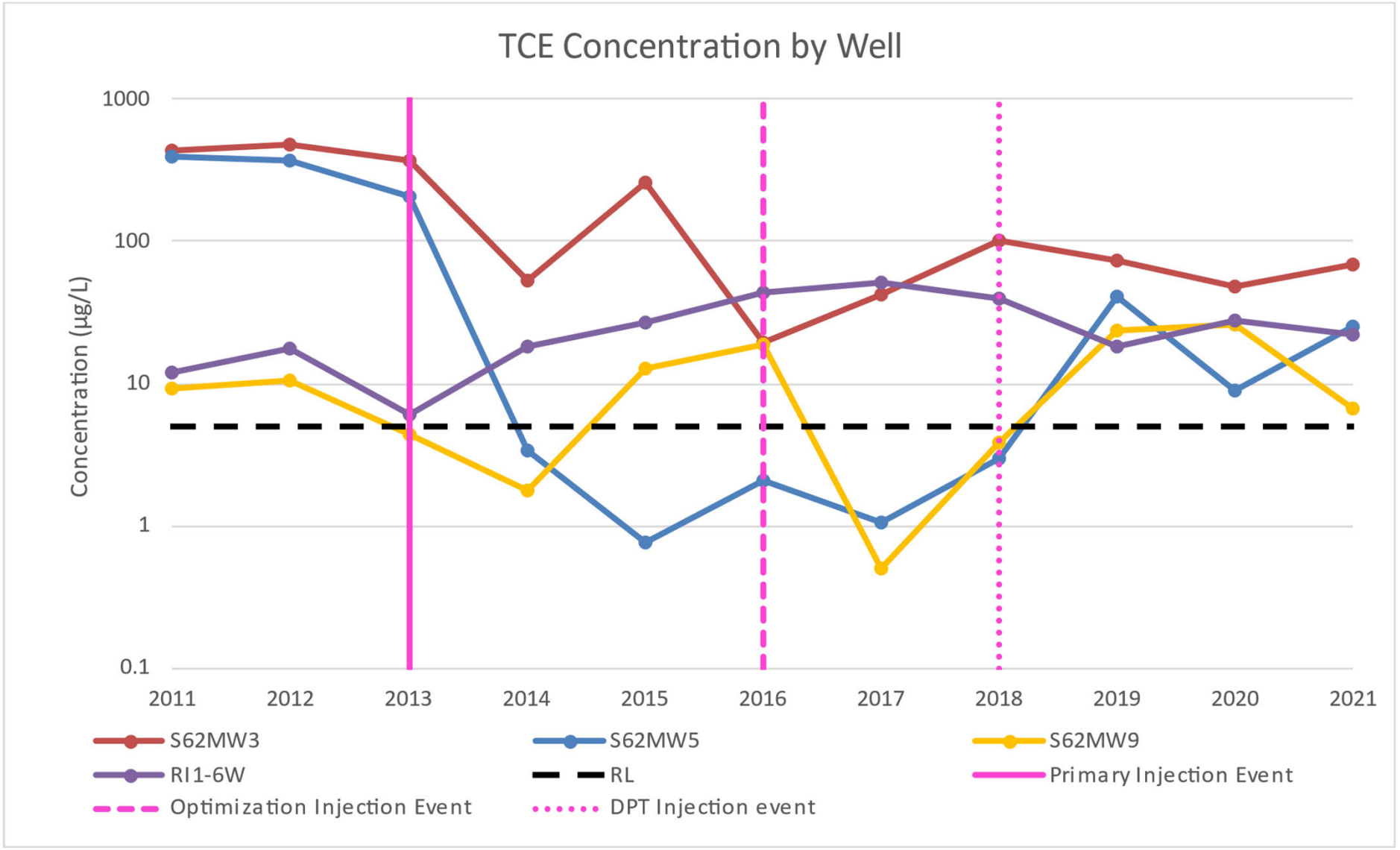
Upper Providence (Bottom)

DPT Grab Groundwater Sample

Temporary Upper Providence Well (Top)

Data Gap Investigation

TCE Concentration Trends



Next Steps

- Continue annual groundwater sampling
- Evaluate alternative oxidants since reducing conditions difficult to achieve
  - Overcome distribution problem
  - Be mindful that CT cannot be oxidized, but can be reduced
- Continue to evaluate permanganate persistence
  - There is no complimentary ISCO treatment that can address CT in presence of $KMnO_4$
  - Small amounts of $KMnO_4$ can be quenched with peroxide prior to MFR

Next Steps

Comparison of Oxidants

Oxidizing Species	Oxidation Potential (volts)
Hydroxyl Radical	2.8
Sulfate Radical	2.6
Ozone	2.07
Persulfate	2.01
Hydrogen Peroxide	1.77
Perhydroxyl Radical	1.7
Permanganate	1.69

Why was $KMnO_4$ initially selected?

- Easiest to manage

Where does hydroxyl radical come from?

- Fenton's reaction chemistry

Next Steps
Modified Fenton's Reagent

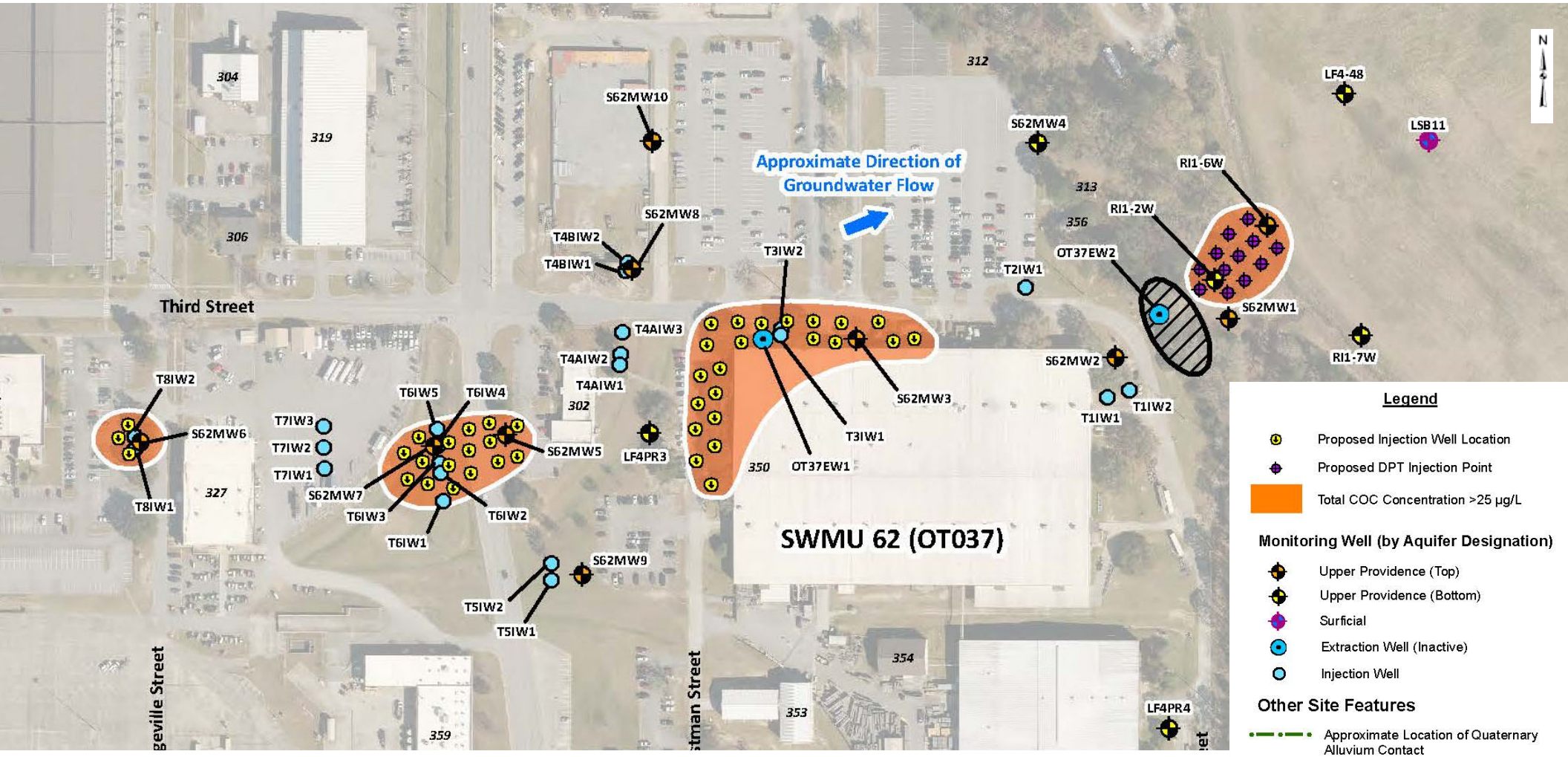
- Hydrogen peroxide with a chelated iron catalyst under neutral pH (>4.8 standard units)
- Treatment mechanism is desorption followed by aqueous treatment
- Promotes distribution in formation and enhances desorption of mass from soil
- Reaction generates hydroxyl radicals and superoxide anions to treat groundwater
- CT does not oxidize, it is reduced by superoxide, a reducing radical

Based on research by Dr. Richard Watts at Washington State University

Next Steps
Proposed MFR Injections

- Larger radius of influence anticipated with MFR than $KMnO_4$
- Target areas with total COCs >25 µg/L first, using grid injection pattern to provide greater coverage than transects
- Use DPT to inject MFR along downgradient end of plume
- Reaction promotes desorption of COCs from soil matrix; therefore, increase in concentration after first injection event is anticipated
- MFR oxidizes COCs in aqueous phase; therefore, multiple injections are planned

Next Steps
Proposed MFR Injections



Path Forward

- **Contract objective: Achieve RLs within Period of Performance (PoP) (by September 2027)**
  - **GA EPD approved Supplemental Site Investigation Report**
  - **Prepare CAP Addendum with Remedial Design/Remedial Action Work Plan for Government and Regulatory approval**
  - **Implement multiple MFR injection events**
- **Upon achievement of RLs, continue long-term monitoring in accordance with CAP throughout duration of PoP**

New Business
and
Program Closing

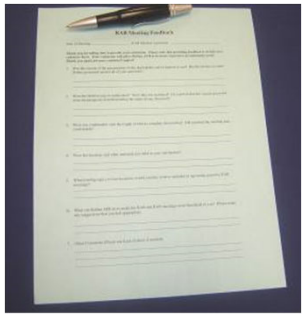
Ms. Shan Williams
EAB Installation Co-chair

Next EAB Meeting

Thursday, November 3, 2022

Please…

Complete the meeting evaluation and feedback form and return to sign-in table or leave at seat



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

Thank you!