Iterative Selection of Remedial Alternatives for Mixed Contaminants in Complex Geology

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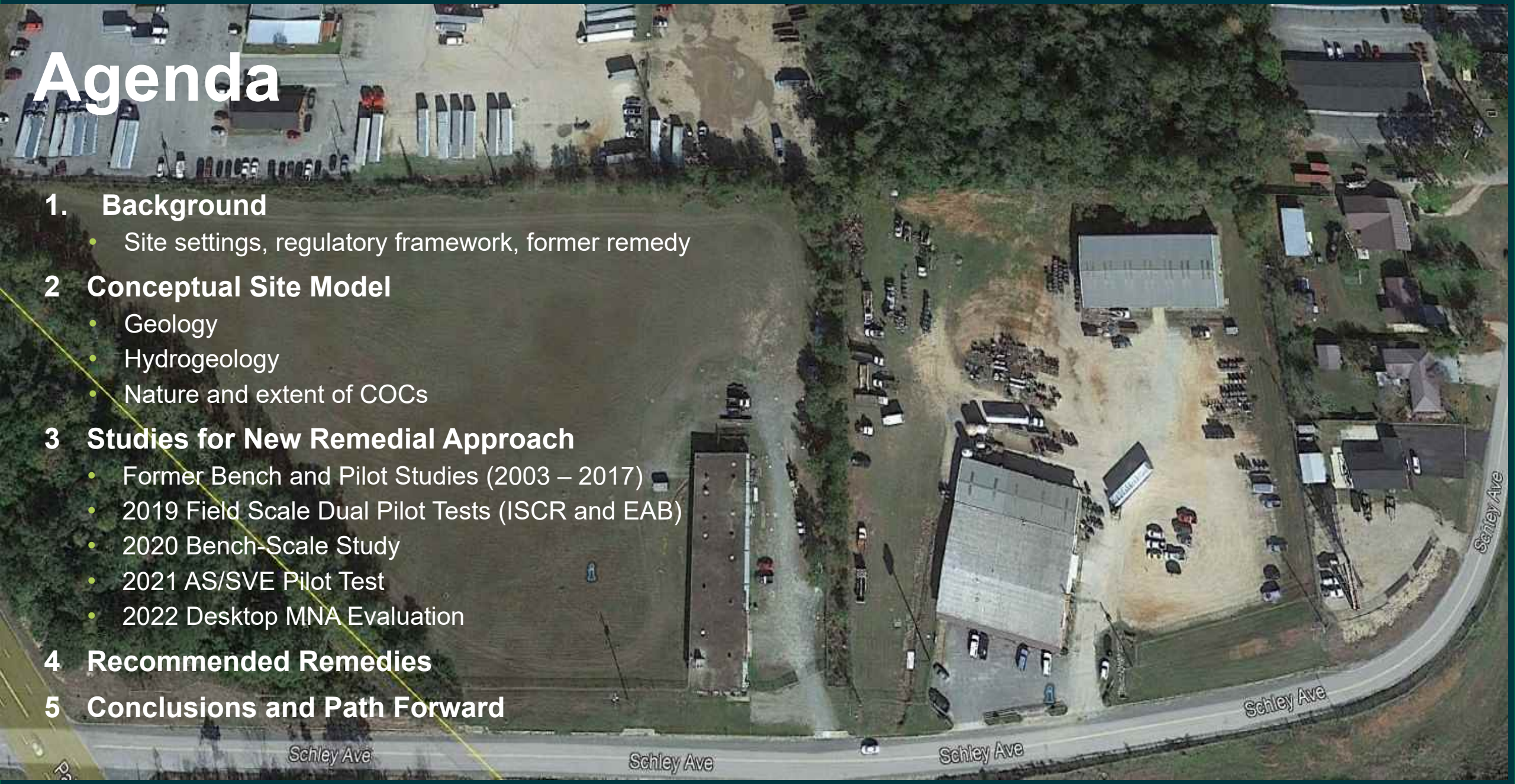
Agenda

1. **Background**
   - Site settings, regulatory framework, former remedy
2. **Conceptual Site Model**
   - Geology
   - Hydrogeology
   - Nature and extent of COCs
3. **Studies for New Remedial Approach**
   - Former Bench and Pilot Studies (2003 – 2017)
   - 2019 Field Scale Dual Pilot Tests (ISCR and EAB)
   - 2020 Bench-Scale Study
   - 2021 AS/SVE Pilot Test
   - 2022 Desktop MNA Evaluation
4. **Recommended Remedies**
5. **Conclusions and Path Forward**



01

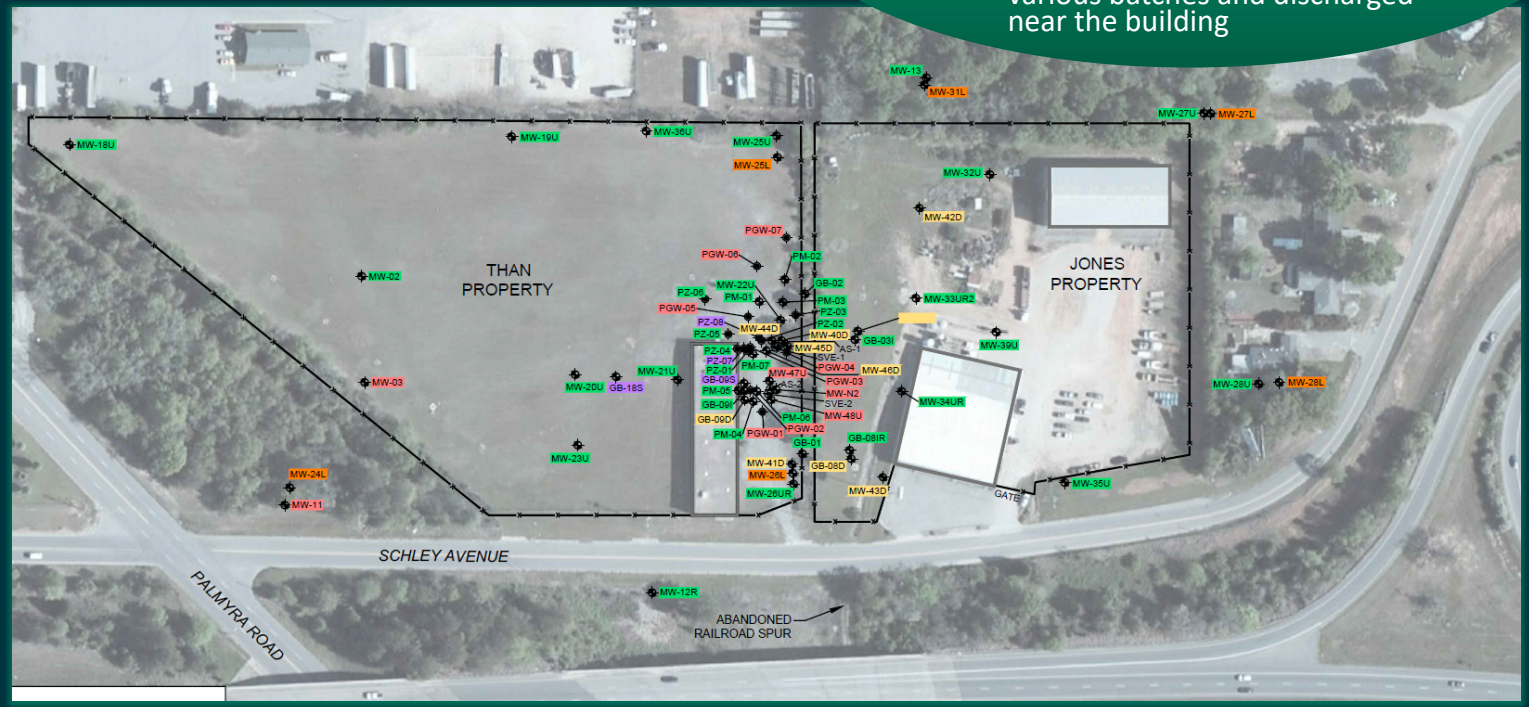
Background

Site Setting and Regulatory Framework

- Superfund Site in Albany, GA
- Two former organochlorine pesticide (OCP) formulating facilities (dry, liquid, wettable powders) from 1950 to 1978.
- Different Responsible Parties
  - Western Parcel = THAN property
  - Eastern Parcel = Jones property

Source of contamination on THAN property

- Sweeping of technical materials for the dry formulations to the floor
- The liquid formulation blending tank rinsed with xylene after various batches and discharged near the building



- OU-1: soil on the THAN property and ground water + LNAPL across both THAN and Jones properties
- OU-2: soils on the Jones property (under a separate ROD)

Former Remedy for OU-1

Before RI
- 1st soil excavation (surficial soil) in 1984 under Georgia EPD mandate

After RI
- 2nd excavation in 1992 (top 1 ft removed and certain areas excavated to 7 ft depth) with USEPA oversight.
- Top 1-ft of clay cap and vegetative cover

1993 ROD
- Surface soil cap deemed effective. Maintain the ICs for land and GW use
- In 1996, P&T system installed, with onsite treatment of the extracted water. LNAPL separator deemed ineffective; bypassed after 2 years

2003
- P&T system deactivated as after 7 year of operation, only 7 lbs. of COCs removed.

2018
- P&T system decommissioned

Process tank on decon pad.

02

Conceptual Site Model

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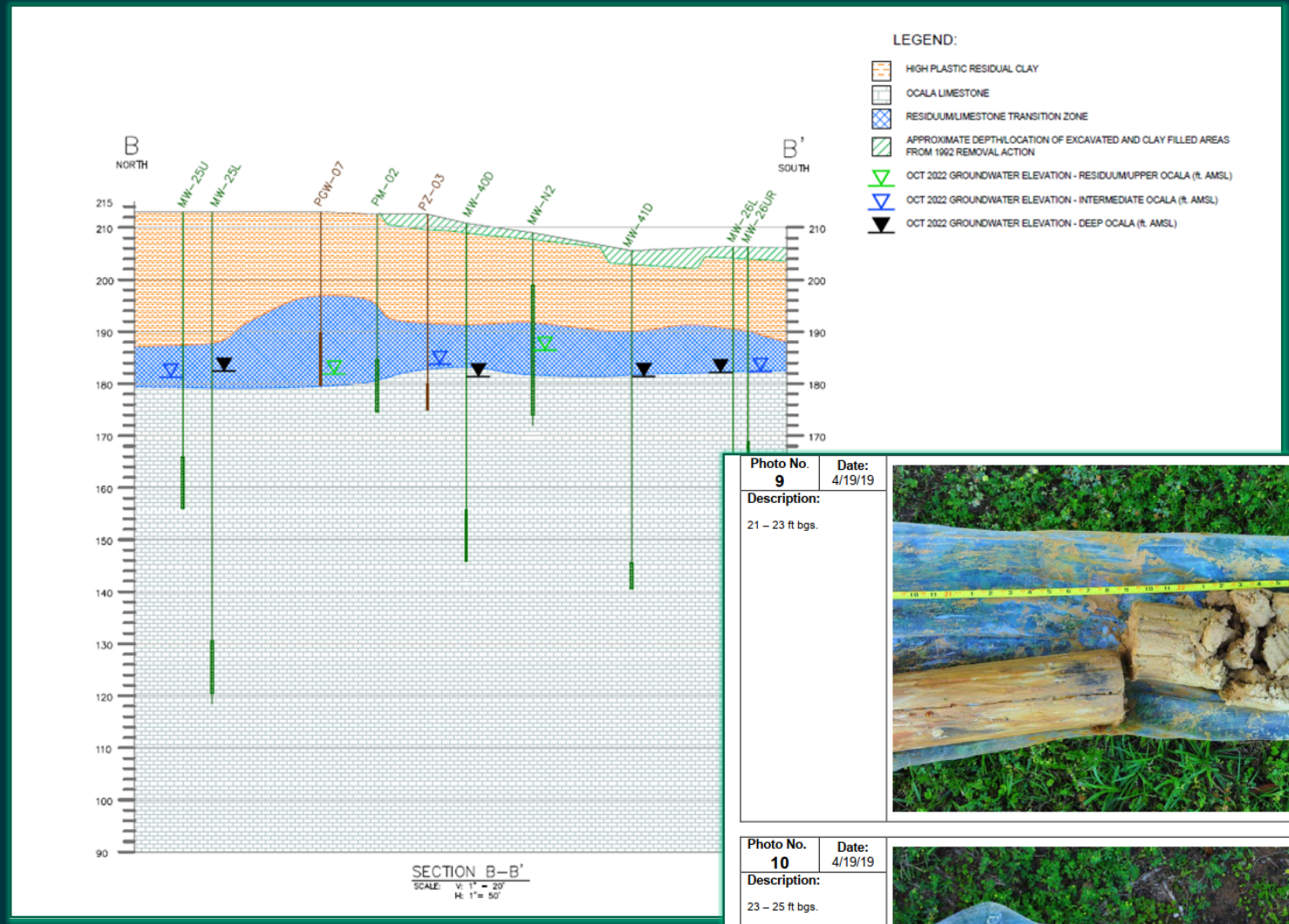
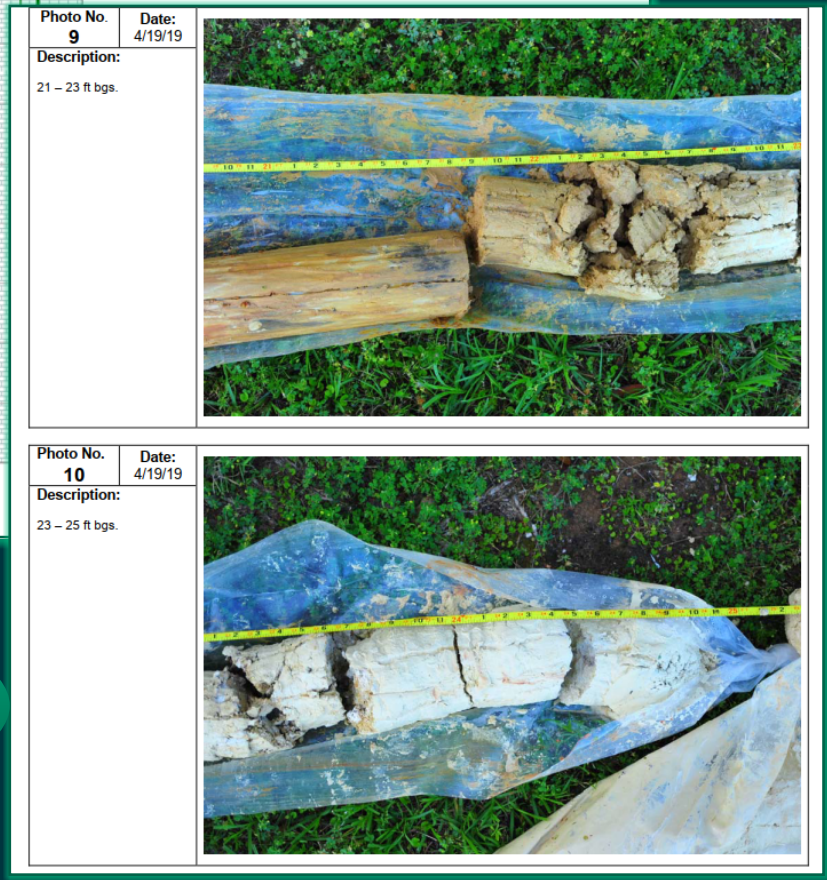
Geology

- Fill
  - 0-3 ft thick
- Residuum (*red residual clay*)
  - 18-26 ft thick
- Ocala Limestone
  - 1-25 ft thick highly weathered (*fine to coarse grained, chalky, soft, fossiliferous with some silts and sands*)
  - Hard brittle with greater depth (with secondary porosities)





GROUNDWATER LEVELS

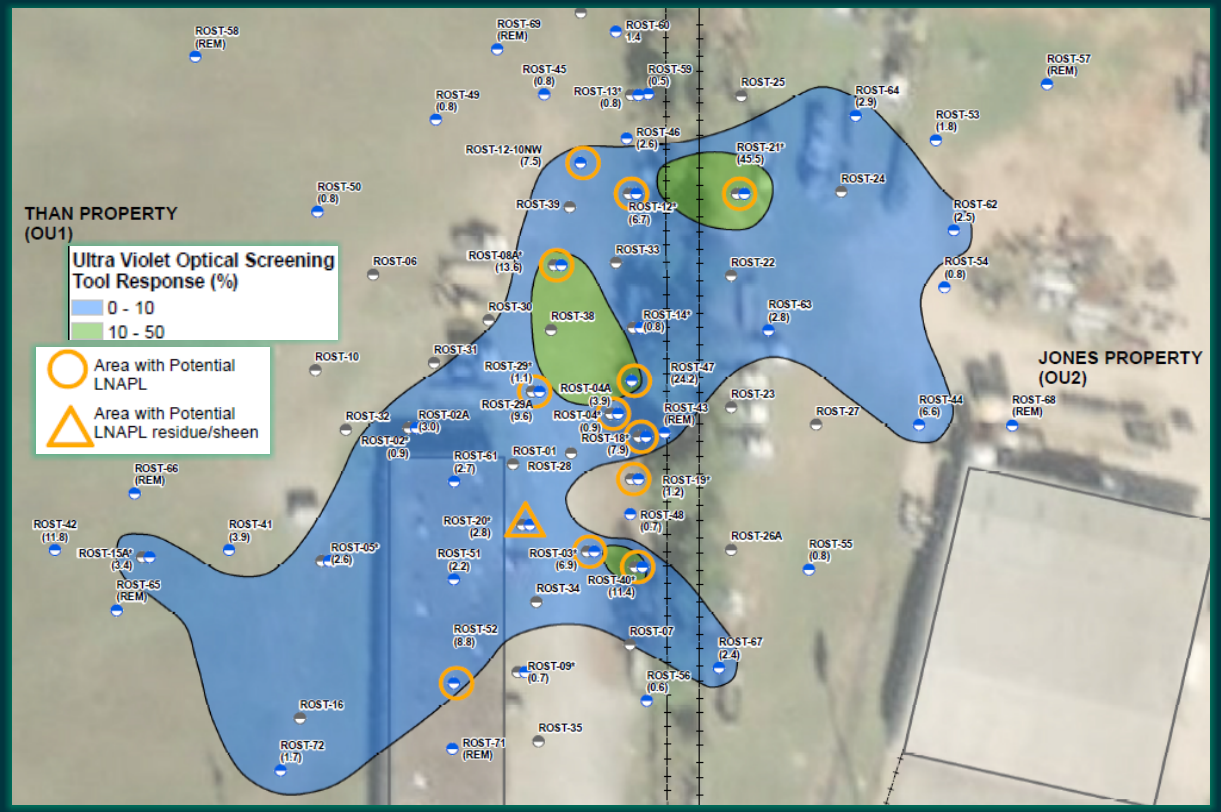
- Surficial aquifer at 10-15 ft bgs in wells screened to ~20 ft bgs
- Pot surface at 25-35 ft bgs for wells screened deeper than 30 ft bgs

Site Characterization/Hydrogeology

HRSC since 2017

UVOST™, slug tests, gamma ray and induction logging, CPT, HPT, EVS modeling

- identify high COC and LNAPL areas
- Identify migration pathways and subsurface zones to target for remedial technologies

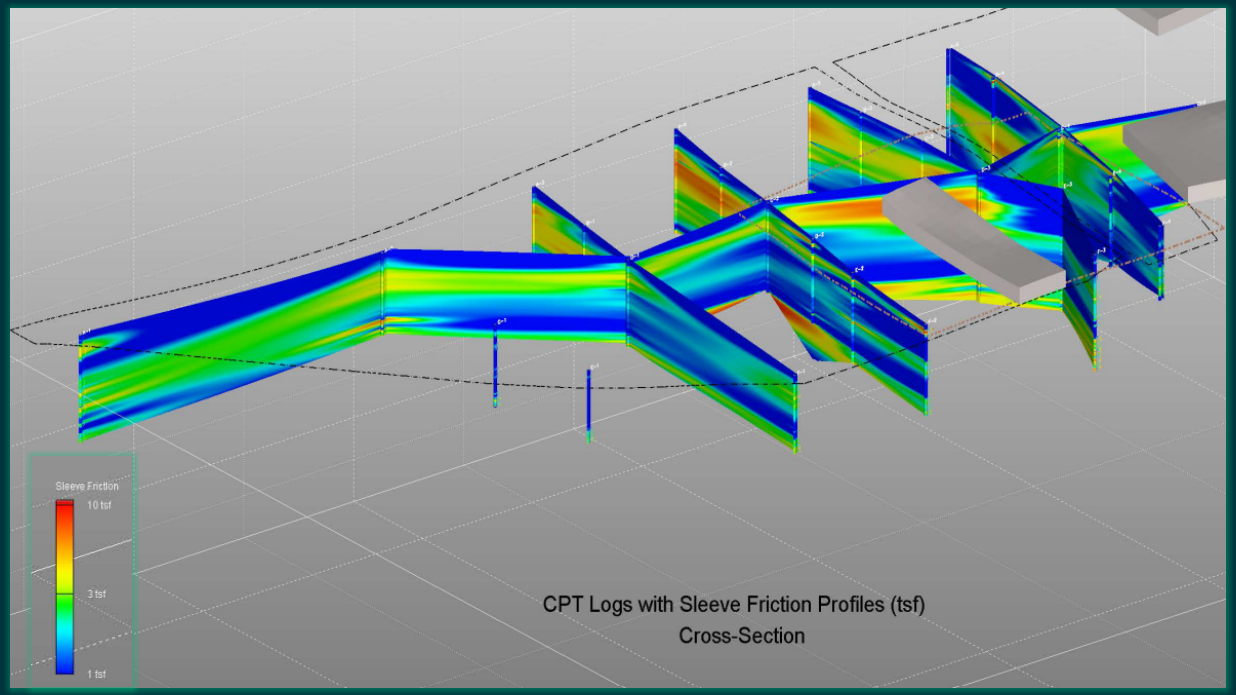


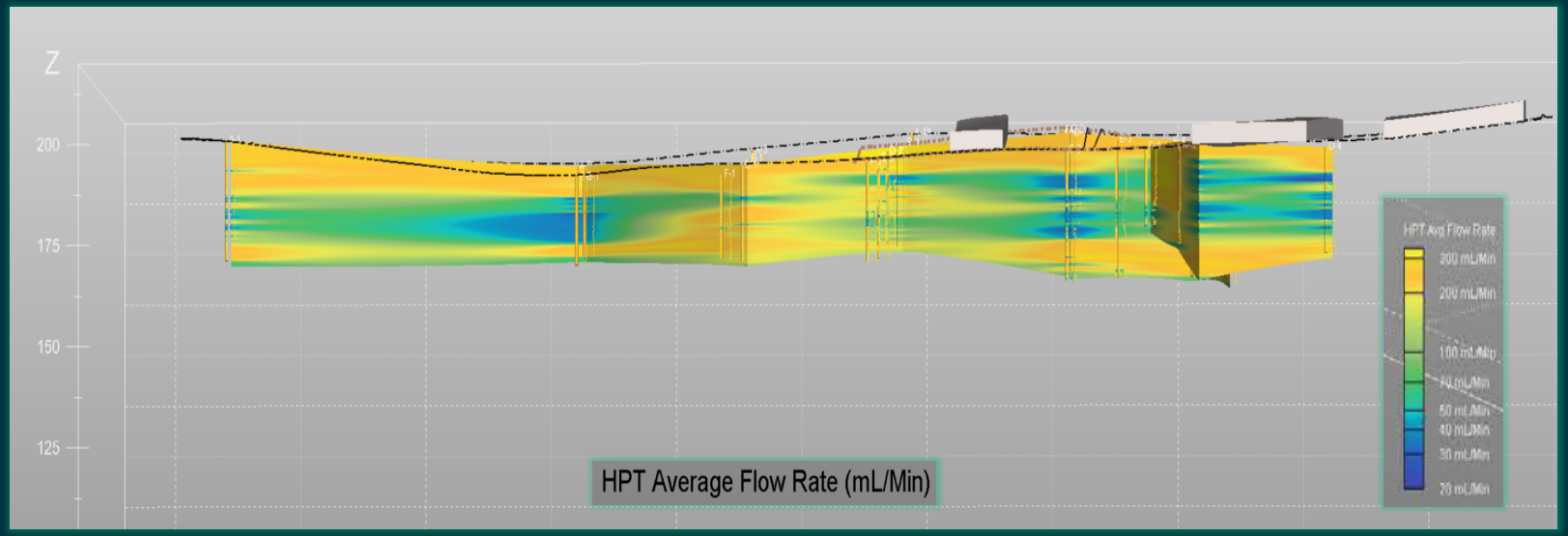
2017 UVOST™

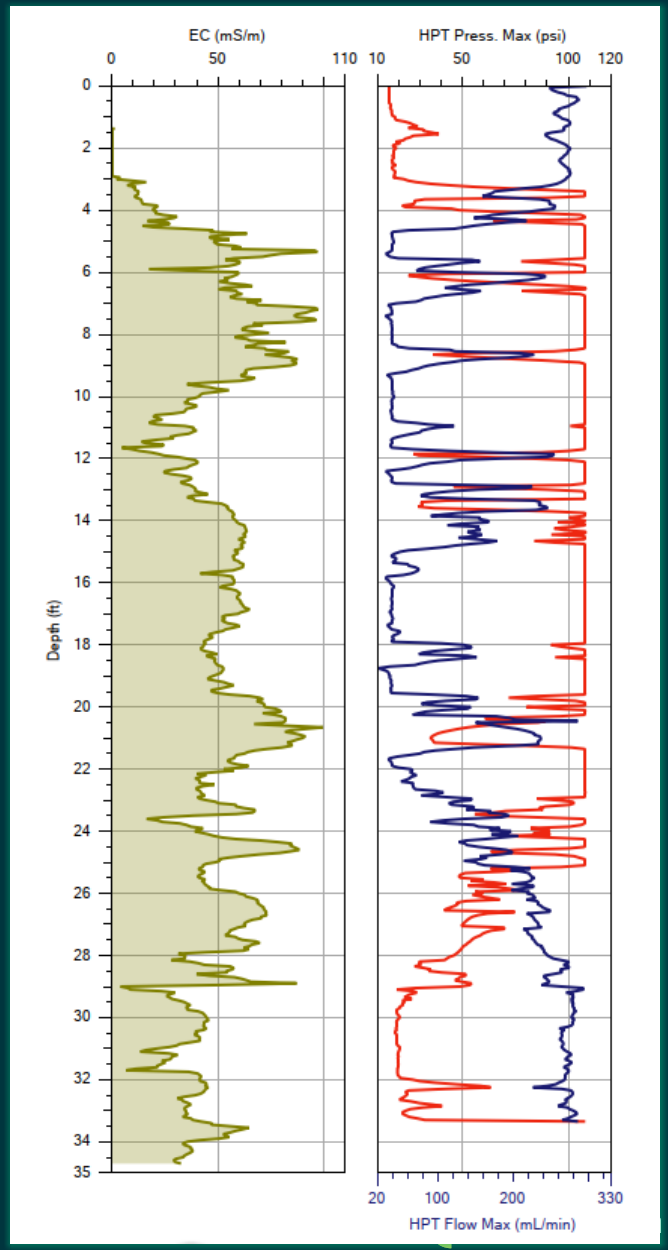
Hydraulic Conductivity

- Residuum and Upper Ocala: 1.1E-05 cm/s - 9.7E-05 cm/s
- Upper Ocala: 3.7E-04 cm/s - 8.4E-05 cm/s
- Intermediate Ocala: 1.83E-03 cm/s - 1.0E-02 cm/s
- Lower Ocala: 9.2E-03 cm/s

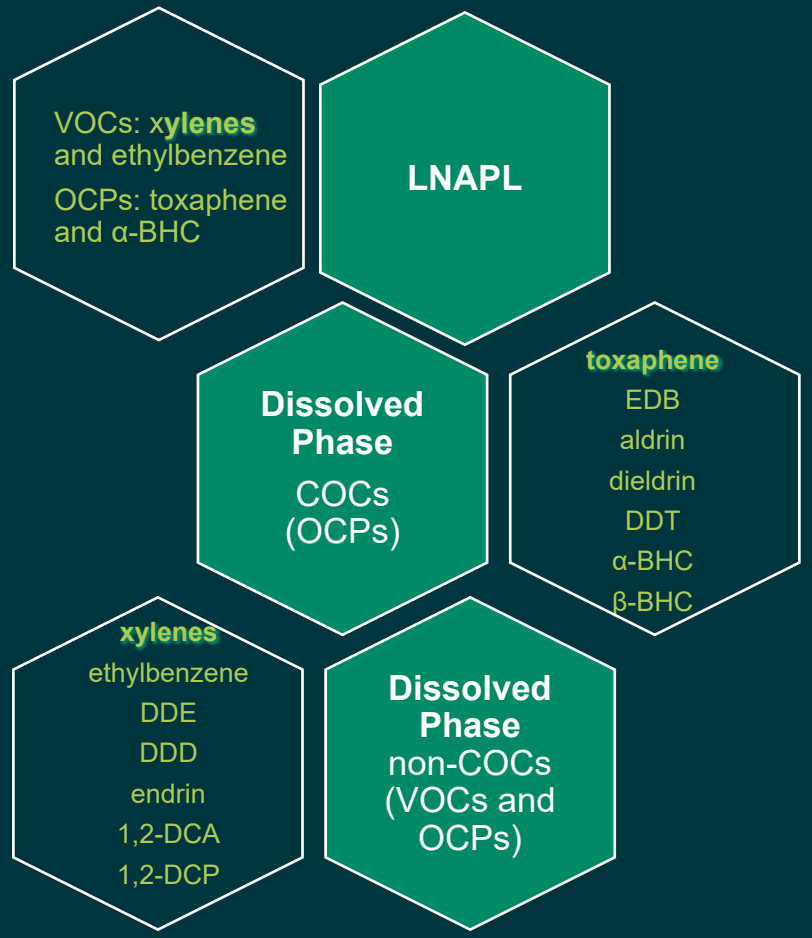
CPT, HPT, EC


Sleeve Friction
10 tsf
3 tsf
1 tsf
CPT Logs with Sleeve Friction Profiles (tsf)
Cross-Section


Z
200
175
150
125
HPT Avg Flow Rate
300 mL/Min
200 mL/Min
100 mL/Min
50 mL/Min
40 mL/Min
30 mL/Min
20 mL/Min
HPT Average Flow Rate (mL/Min)


EC (mS/m)
0
50
110
HPT Press. Max (psi)
10
50
100
120
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
35
20
100
200
330
HPT Flow Max (mL/min)

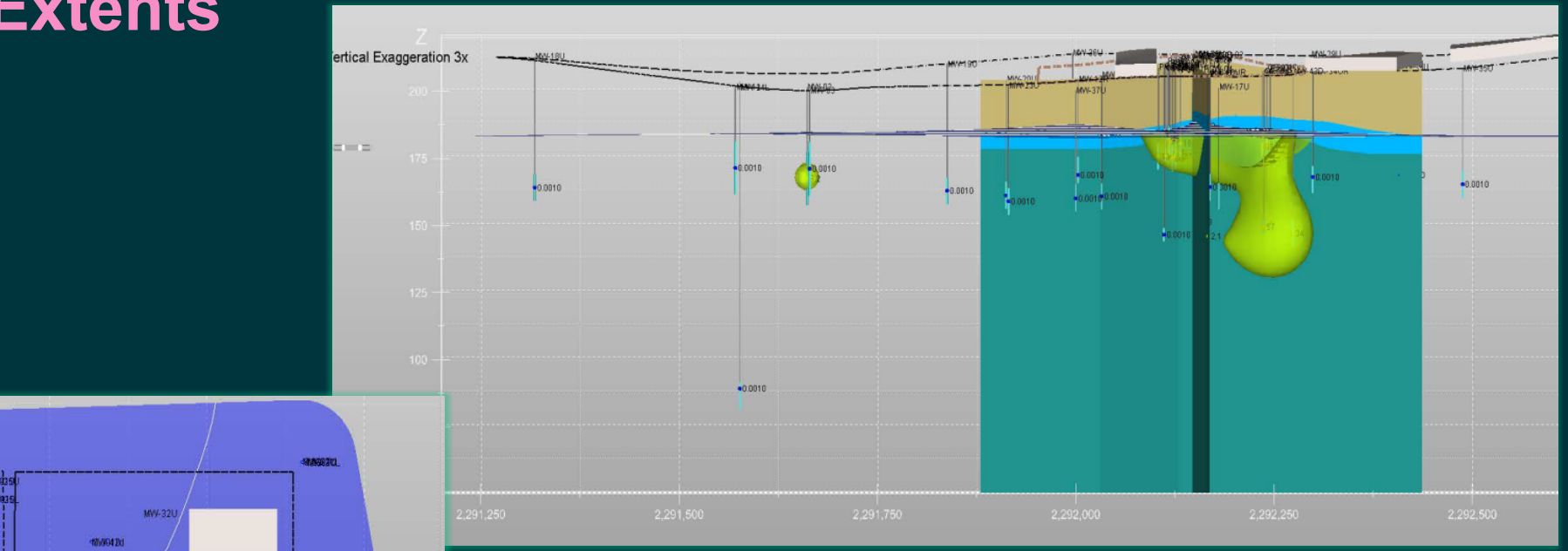
Nature and Extent of Impacts- Groundwater



EXPOSURE PATHWAYS

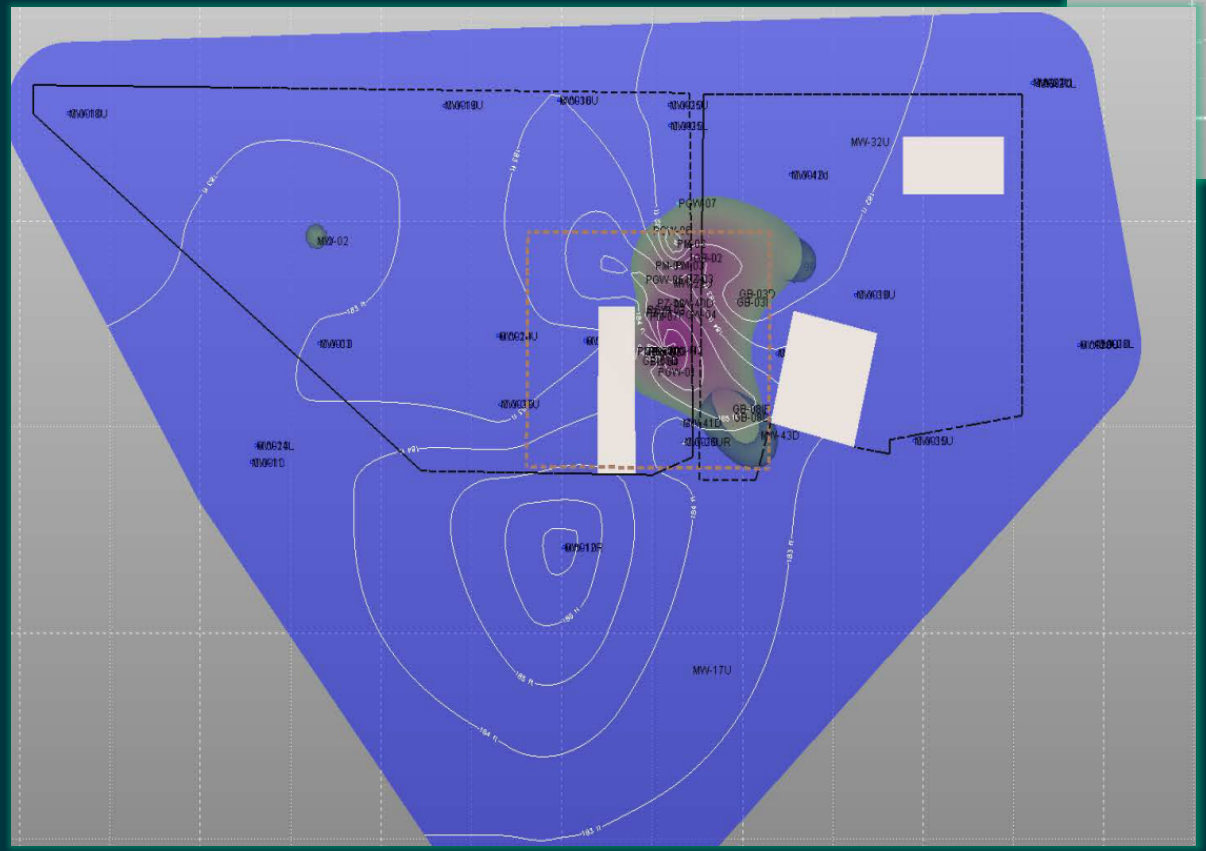
- **Soil exposure** has already been addressed by the former excavations and implementing ICs.
- The exposure pathways that need to be addressed are for GW and LNAPL:
  - Potential dermal exposure by a trespasser to surface water, and
  - Future ingestion of contaminated groundwater by near-site or on-site residents.
- VI pathway is considered incomplete because of the thick residuum

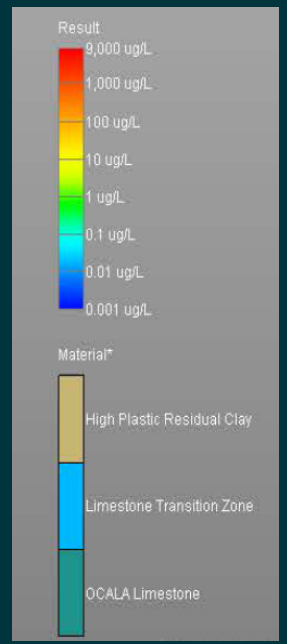
Toxaphene – 2019 Extents



Cross-section, with geology

Aerial, with groundwater flow





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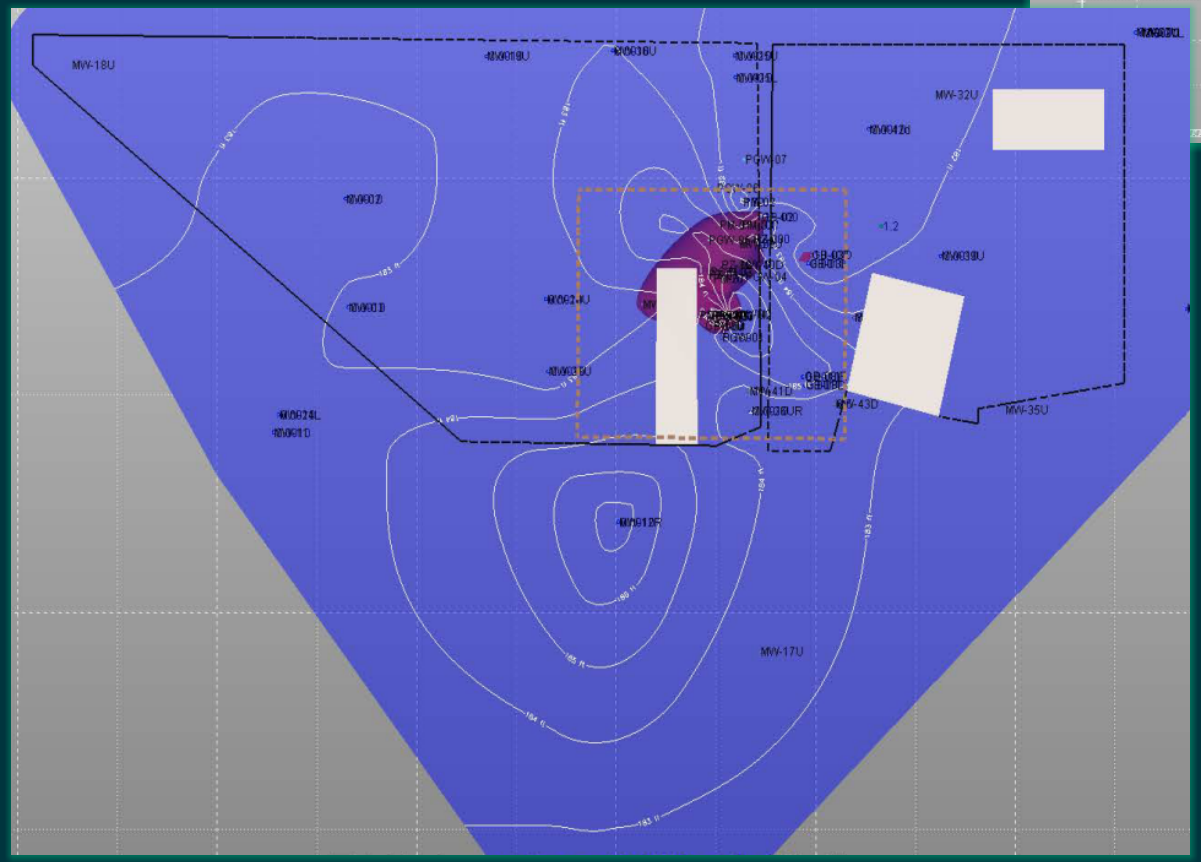
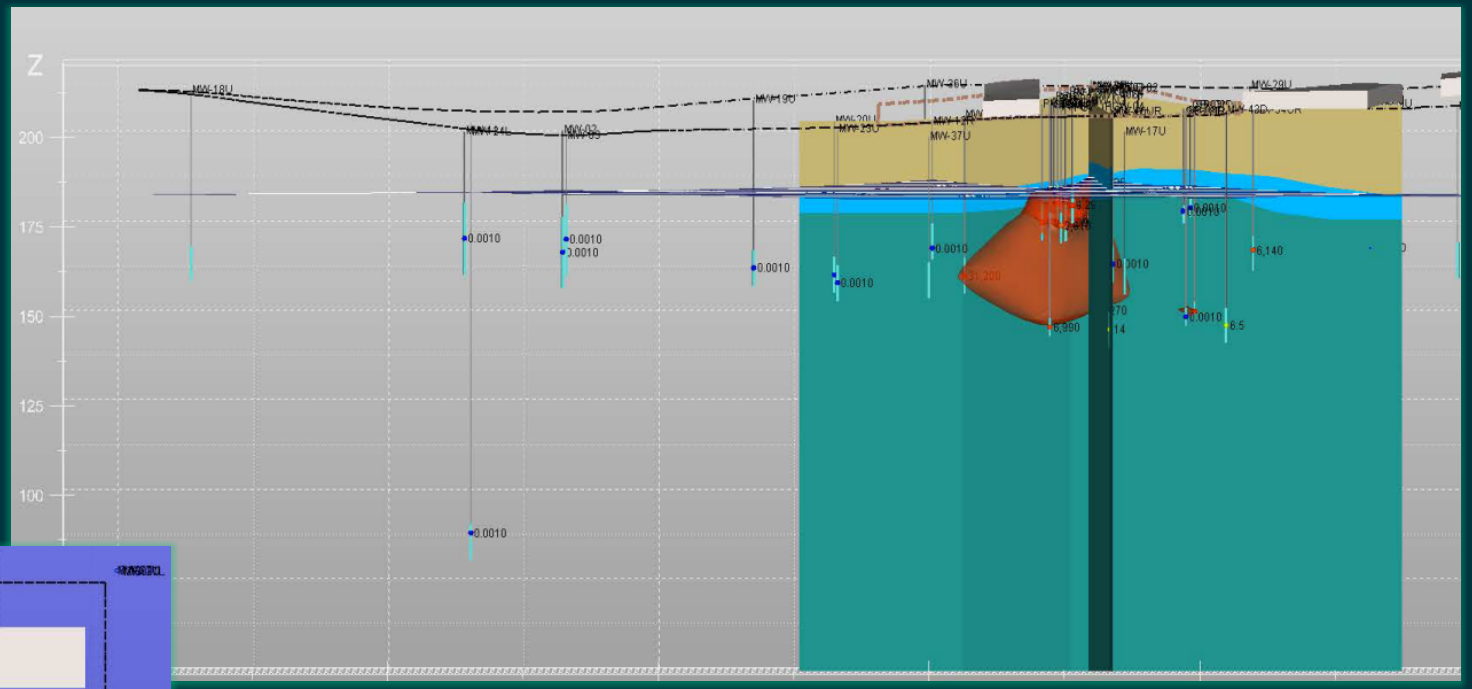
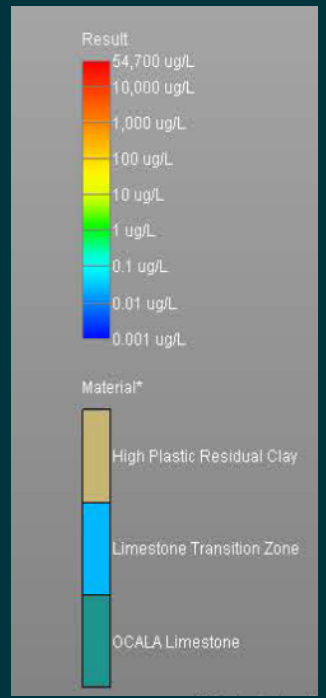
Xylenes – 2019 Extents

Aerial, with groundwater flow





Cross-section, with geology



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03

Studies for New Remedial Approach

Former Bench and Pilot Studies

2003 Bench Studies

3 bench scale studies completed in 2003

- Daramend®
- ISOTEC's Modified Fenton's Reagent
- Simultaneous comparison of chemical oxidation by Fenton's reagent, permanganate, persulfate, and ozone

Daramend® chosen for pilot

2003 – 2007 Pilot Study

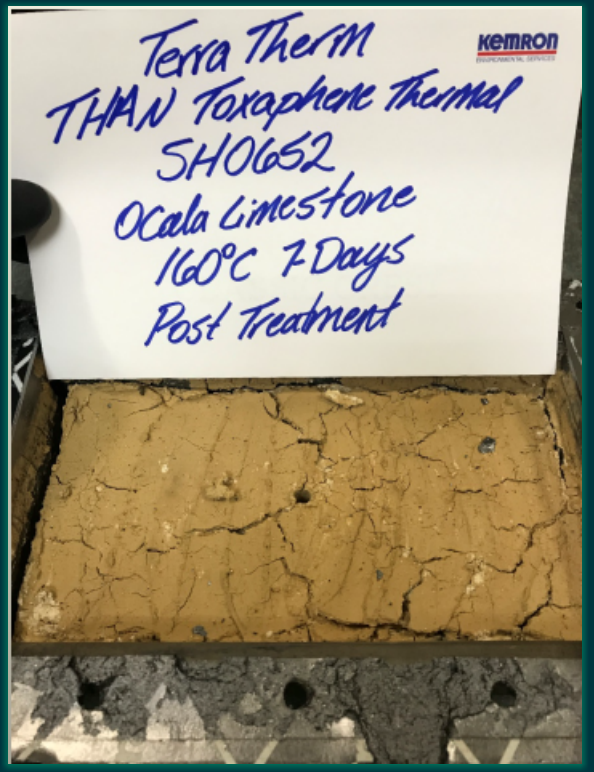
- Slurry of Daramend® targeted the top 3 to 4 ft of the Ocala Limestone by hydraulic fracturing
- Problems included irregular fractures, and limited distribution
- Sampling did not demonstrate obvious decreasing trends for VOCs or OCPs

Used as a basis for the 2019 tests

2017 In Situ Thermal Desorption Bench Study

- Highly impacted Ocala Limestone tested at 100°C, 160°C, and 250°C
- OCPs required at least 160°C for complete breakdown
- But dewatering or barrier wall required for full-scale

Eliminated due to high $$ and only partial treatment



2019 Field Scale Dual Pilot Tests

- EHC® and GeoForm™ Soluble provided by **Evonik (formerly PeroxyChem)**
- Direct push, injections, soil borings, and well install by **Geo Lab Drilling**

Pilot Test Area A: 25% EHC® ISCR slurry

- Direct push into 15 locations. Bottom up into the weathered Ocala Limestone
- EHC® consists of controlled release carbon, ZVI, and nutrients

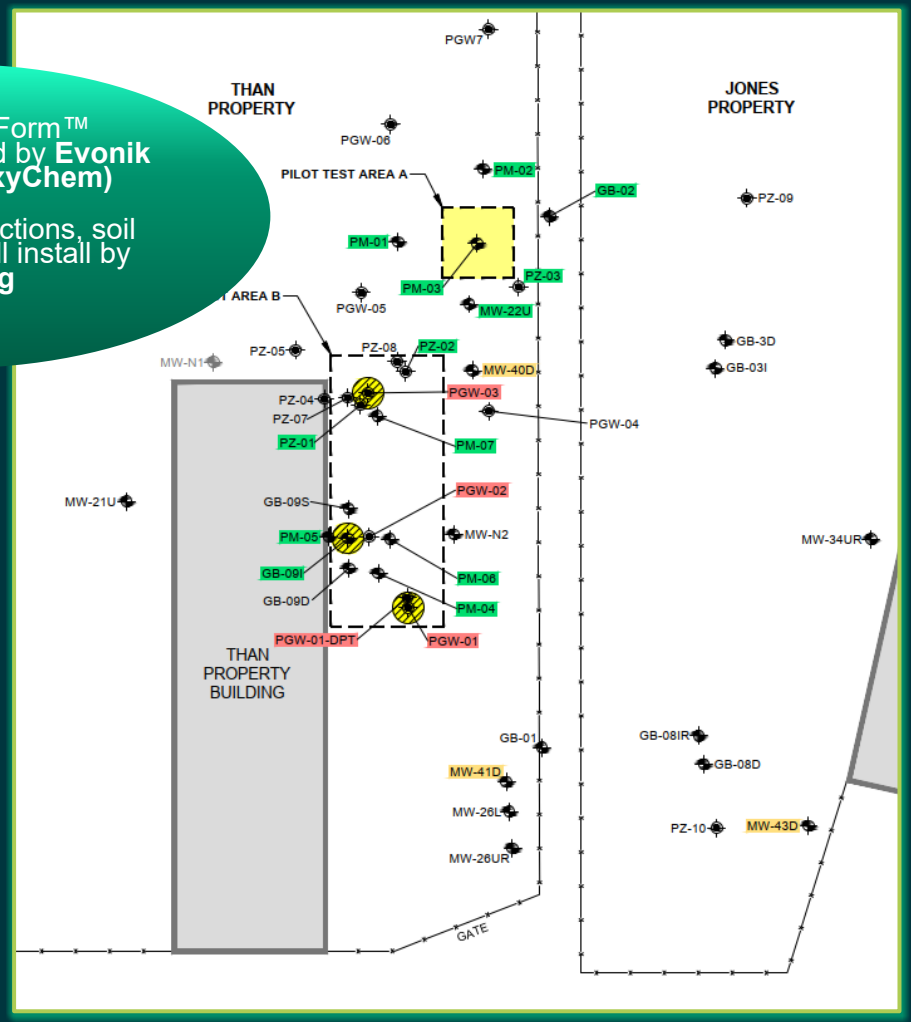
Pilot Test Area B: GeoForm™ Soluble

- Injected as a solution into 3 existing MWs
- GeoForm™ Soluble consists of sulfate, ferrous iron, ELS® microemulsion organic carbon

Post-injection soils borings and magnetic susceptibility (MS) for evidence of influence

- Highest MS readings were at or below the residuum-weathered limestone interface
- Chloride concs and methane went up

Performance monitoring for 6Q concluded that EHC® is a viable full-scale treatment technology for OCPs



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2020 Bench-Scale Treatability Study - GeoForm™ Extended Release

WHY

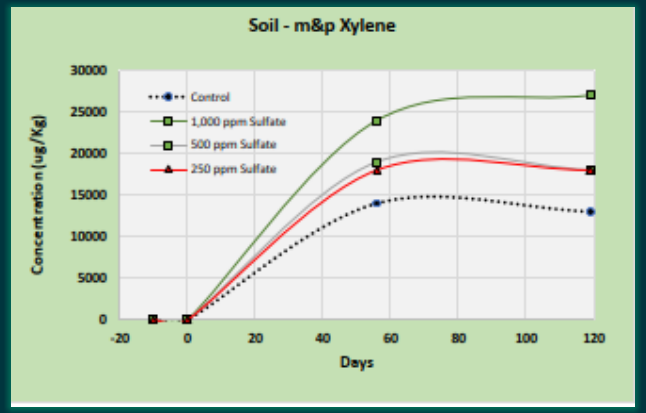
- Evidence of attenuation of OCPs in Area A (from the use of EHC®) and VOCs in Area B (from the use of GeoForm™ Soluble)
- Combination single amendment to treat the OCPs and VOCs?

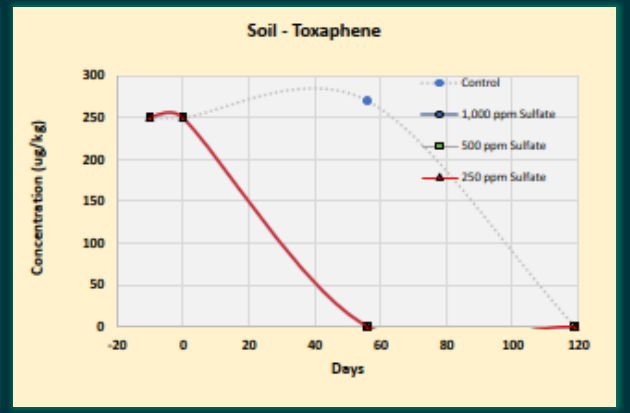
WHAT

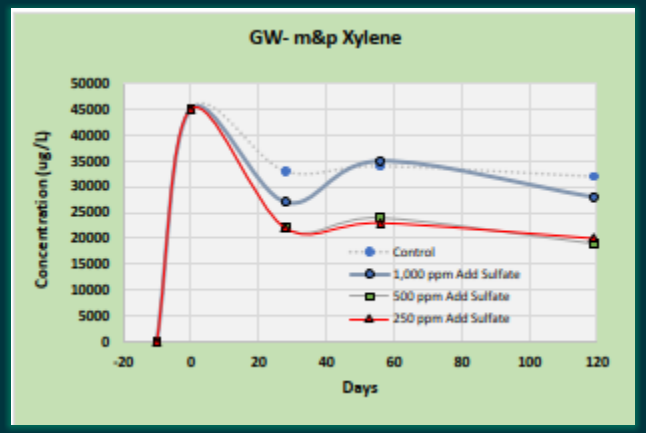
- GeoForm™ Extended Release, (combo of EHC® and GeoForm™ Soluble)
- Establish an optimal sulfate conc. to allow sufficient formation of iron sulfides for abiotic reduction

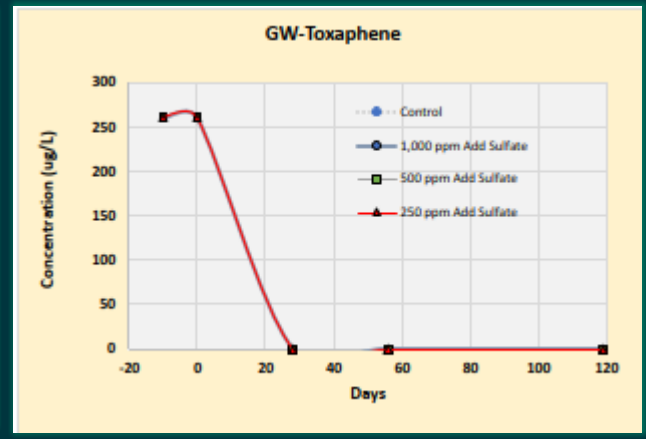
KEY RESULTS

- Sulfides were quickly formed; partially responsible for the degradation of OCPs in both soil and GW
- Xylene only partitioned from one media to the other. No degradation









Combination amendment eliminated from consideration

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2021 AS/SVE Pilot Test

WHY

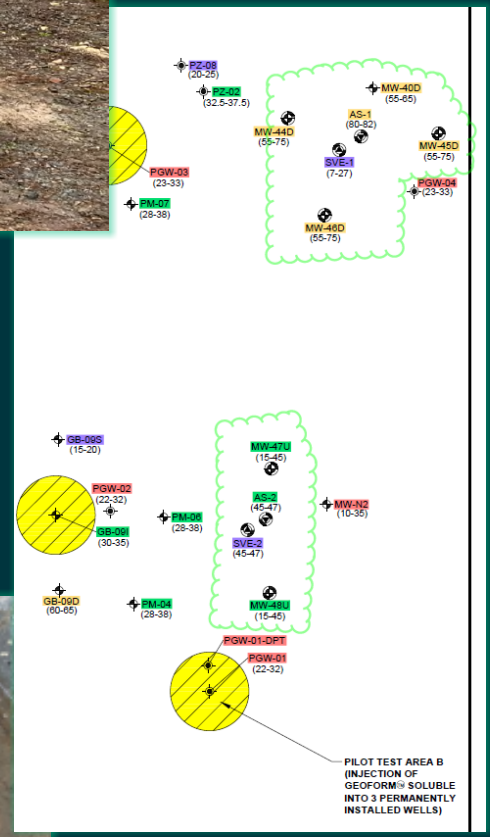
- Minimal success in the treatment of xylenes during the 2019 pilot test and 2020 bench-scale study
- AS is well-established for volatile LNAPL and VOCs

WHAT

- 2-day pilot with two AS wells (AS-1 and AS-2), two SVE wells (SVE-1 and SVE-2)

KEY RESULTS

- Bubbling, DO conc increases, and PID readings. Faster observations in the Intermediate Ocala zone
- Carbon loading ~ 0.04 lbs./day with AS on
- Air injected into deeper AS-1 had greater ROI (15 ft) than the shallow AS-2 (12 ft)



2022 Desktop MNA Evaluation

WHY

- In the non-LNAPL area, determine if natural attenuation of OCPs is occurring
- If solvents (xylenes) are removed, can MNA achieve cleanup levels for OCPs

WHAT

- Used data from 2003 to 2021 to evaluate attenuation rates and cleanup-time frames
- Linear regression and 90% confidence interval

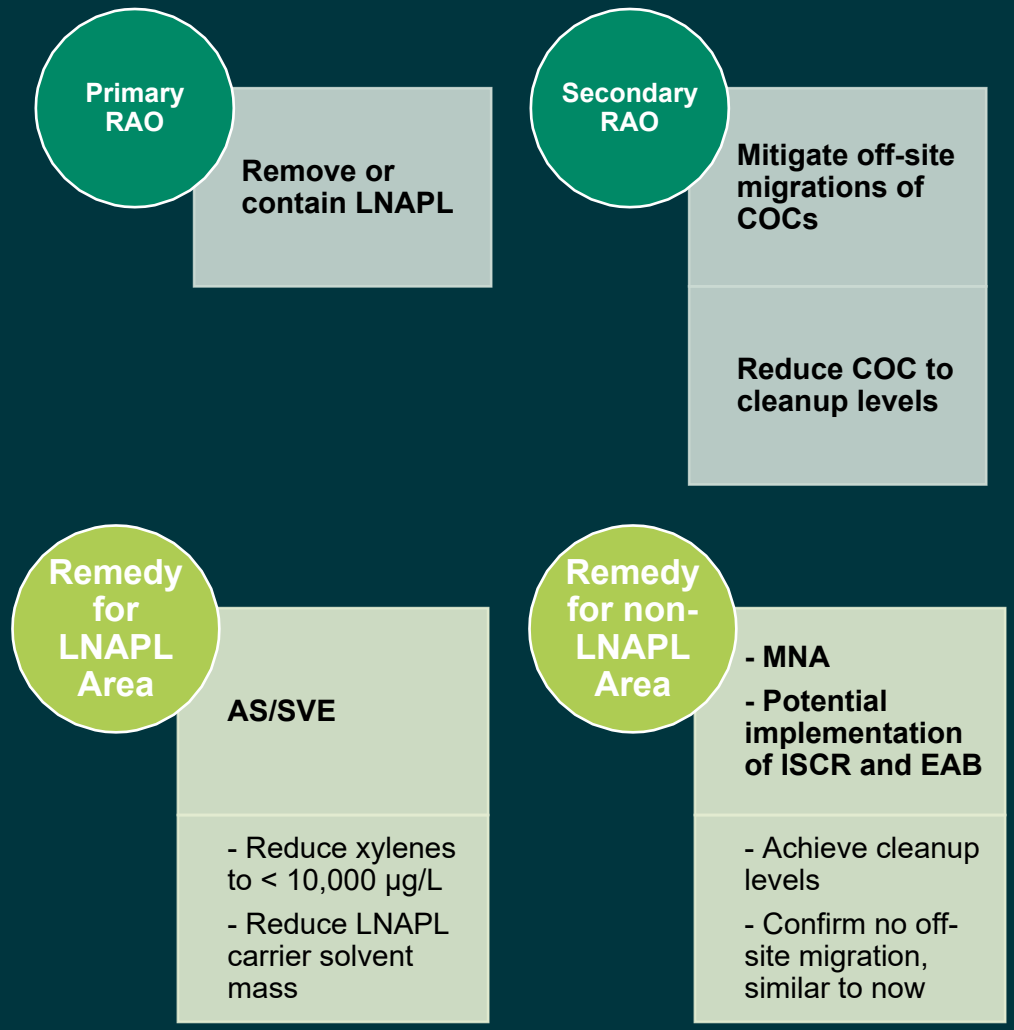
KEY RESULTS

- For all COCs evaluated in non-LNAPL area, MAX clean-up time frame ranged from 30-40 years
- Repeated attenuation analyses will need to be performed based on sequenced remedies at the Site
    - If attenuation rate to low or clean-up time frame too high, need to switch to ISCR/EAB

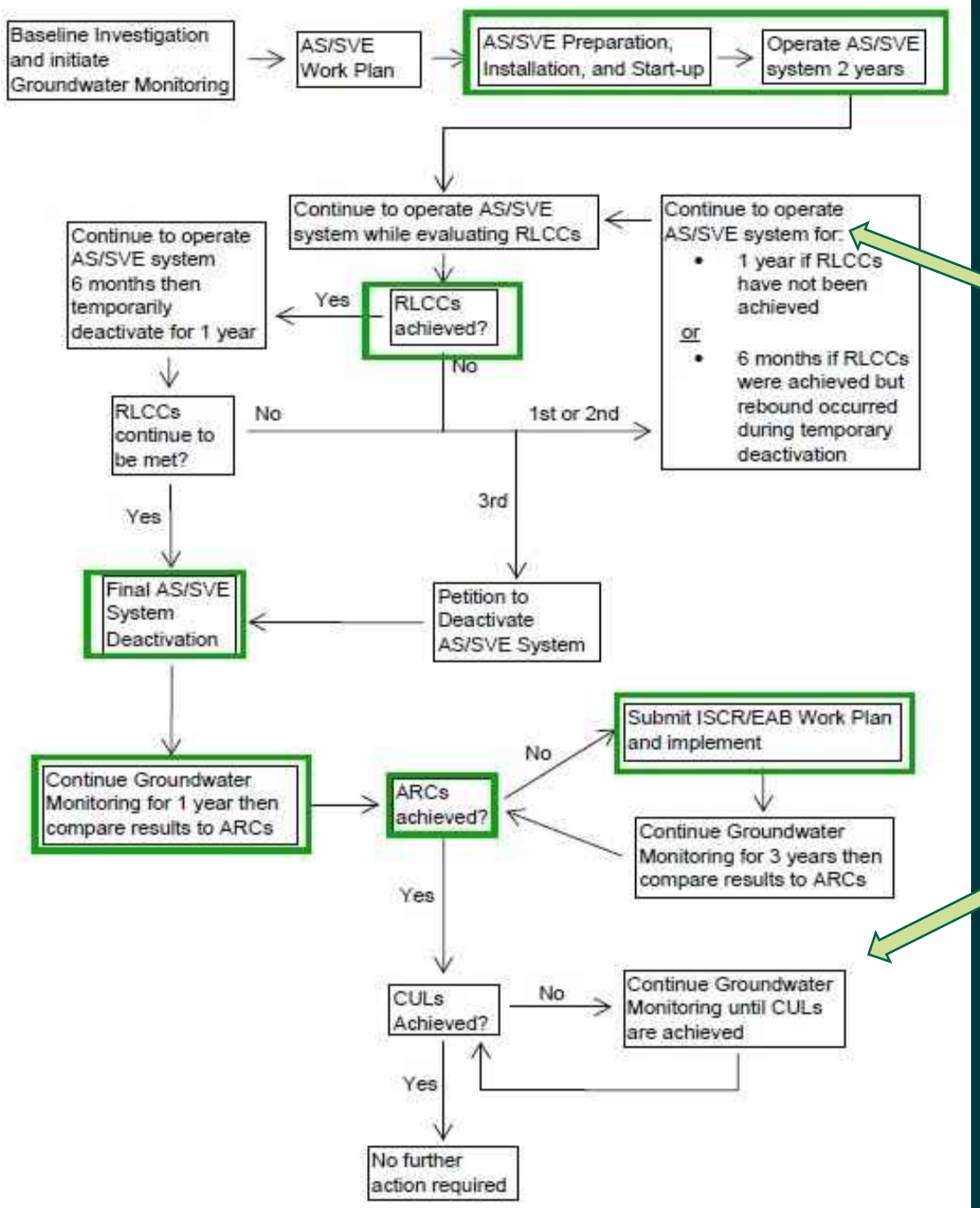
04

Recommended Remedies

RAOs and Remedies in FFS



Remedy Management Plan Flow Diagram



LNAPL Area

Non-LNAPL or Dissolved Plume Area

Acronyms:
ARC = Active Remediation Criteria
CUL = Cleanup Level
RLCC = Residual LNAPL Cleanup Criteria

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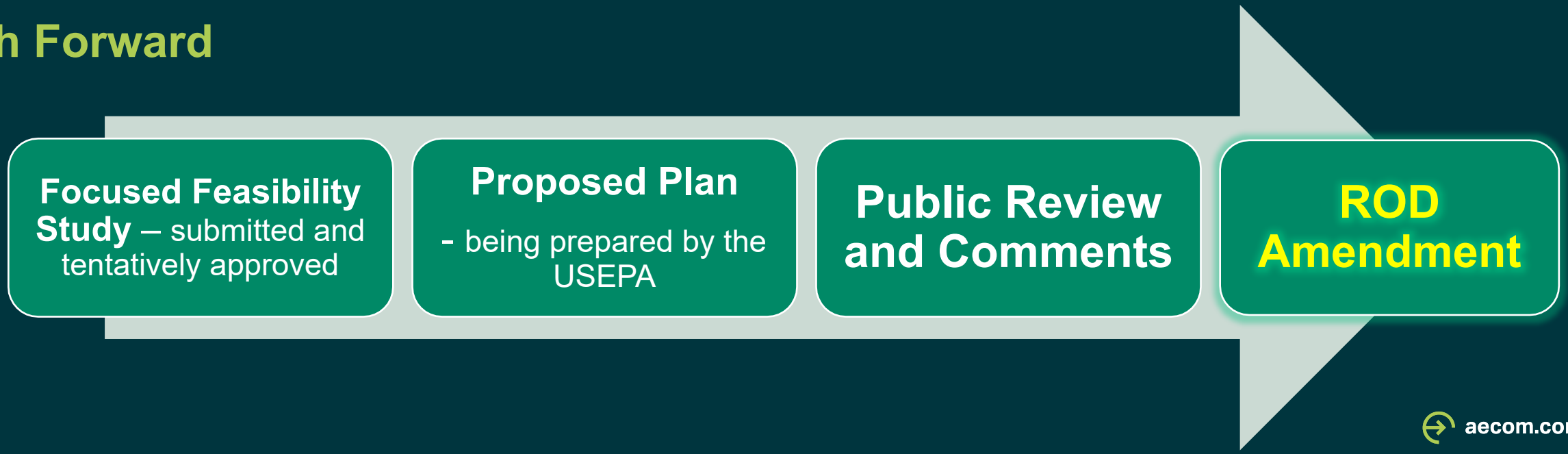
05

Conclusions and Path Forward

Conclusions

1. Improved understanding of subsurface geology, aquifer, and extent of contamination
2. Used lessons learned from former pilot studies to enable better implementation for newer studies
3. Eliminated certain technologies based on pilot and field studies
4. Proposed use of a remedy management plan for sequenced implementation for a combination remedy

Path Forward



Thank You!

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