U.S. DEPARTMENT OF ENERGY | Legacy Management

2018 Long-Term Stewardship Conference

August 20–23, 2018
Grand Junction, Colorado

Expediting Groundwater Remediation Through Enhanced Attenuation at the Mound, Ohio, Site

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Track 1.2: Groundwater Remediation and Compliance, Part 1

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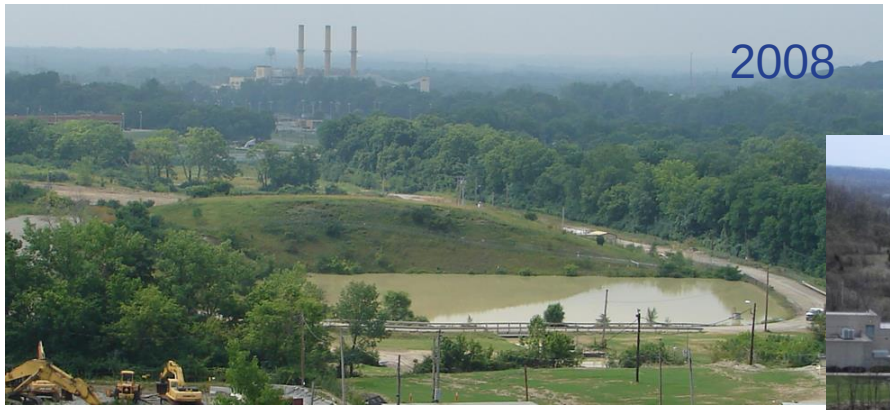
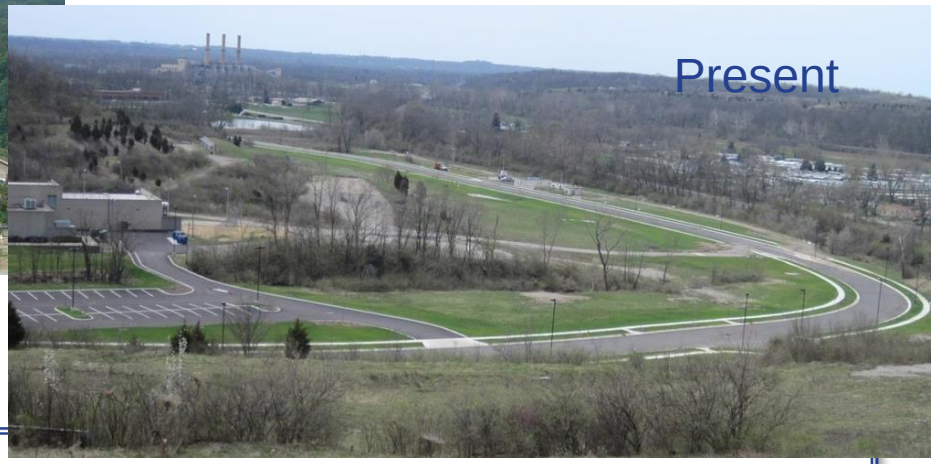
Background – Mound Site

- Operated 1948-2003 as an integrated research, development, and production facility to support the nation's energy and weapons programs
  - Stable isotope separation, fossil fuels research, tritium recovery, and development of radioisotope thermoelectric generators
- Named to National Priority List (1989) due to volatile organic compound (VOC) contamination in groundwater
  - Proximity to Buried Valley Aquifer
- Record of Decision signed in 1995: Collection, Treatment and Disposal of groundwater
  - Pump and treatment

Site Overview

Background – Operable Unit 1





Landfill Operations
disposal of trash, debris and liquid waste

bulk waste relocation
& encapsulation

groundwater pump & treat ...

soil vapor extraction

Mound production
wells "abandoned"

waste & soil removal

65 year OU-1 history
relevant to groundwater

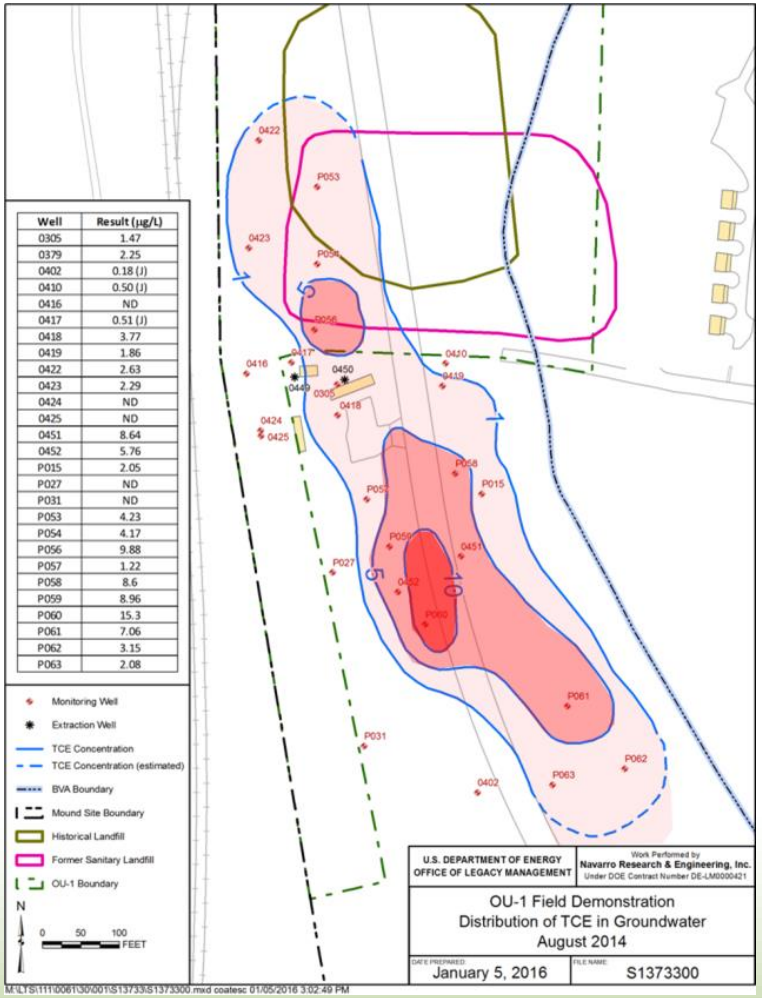
1950 1960 1970 1980 1990 2000 2010 2020

Remedy Progress

- P&T removed 26 lbs of cVOCs from 1997-2014
  - Expected to achieve cleanup standards for VOCs in groundwater by 2040
- Soil vapor extraction removed approximately 4100 lbs of VOCs (1997-2003)
- Rebound tests (2003 and 2011)
  - 2003 rebound test conducted prior to OU-1 landfill excavation
  - 2011 rebound test conducted after OU-1 landfill excavation
- Comprehensive evaluation of VOCs (2012 – 2013)
  - No primary sources of VOCs remaining
  - Former landfill would be continued long-term source
  - Generally low levels of cVOCs remained (<50 µg/L)
- Any way to expedite remediation?

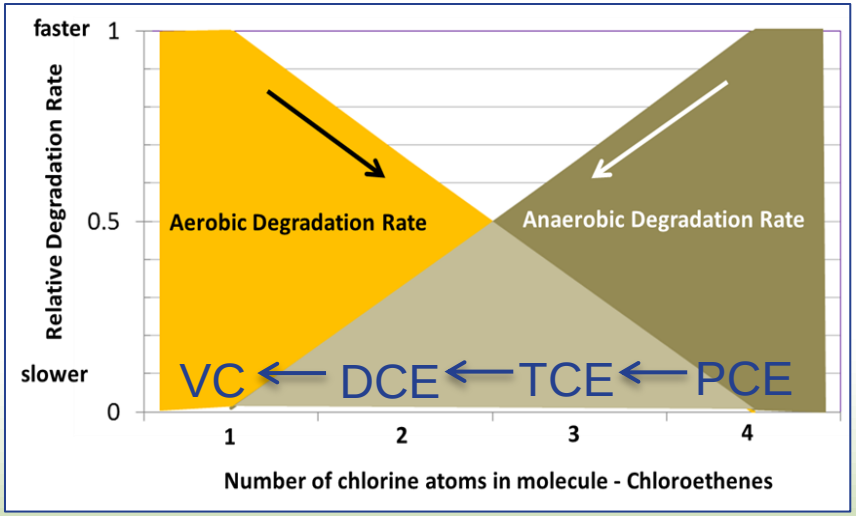
Geochemical Conditions in OU-1 (2014)

- Aquifer is generally aerobic
- Groundwater in contaminated areas is generally anaerobic
- Reductive dechlorination of perchloroethene (PCE) to trichloroethene (TCE)
- Subsequent reductive dechlorination of TCE to cis-1,2-dichloroethene (DCE) is limited
- Cometabolic aerobic oxidation of TCE and cis-1,2-DCE is feasible
- Site is a suitable candidate for Enhanced Attenuation



Enhanced Attenuation Field Demonstration

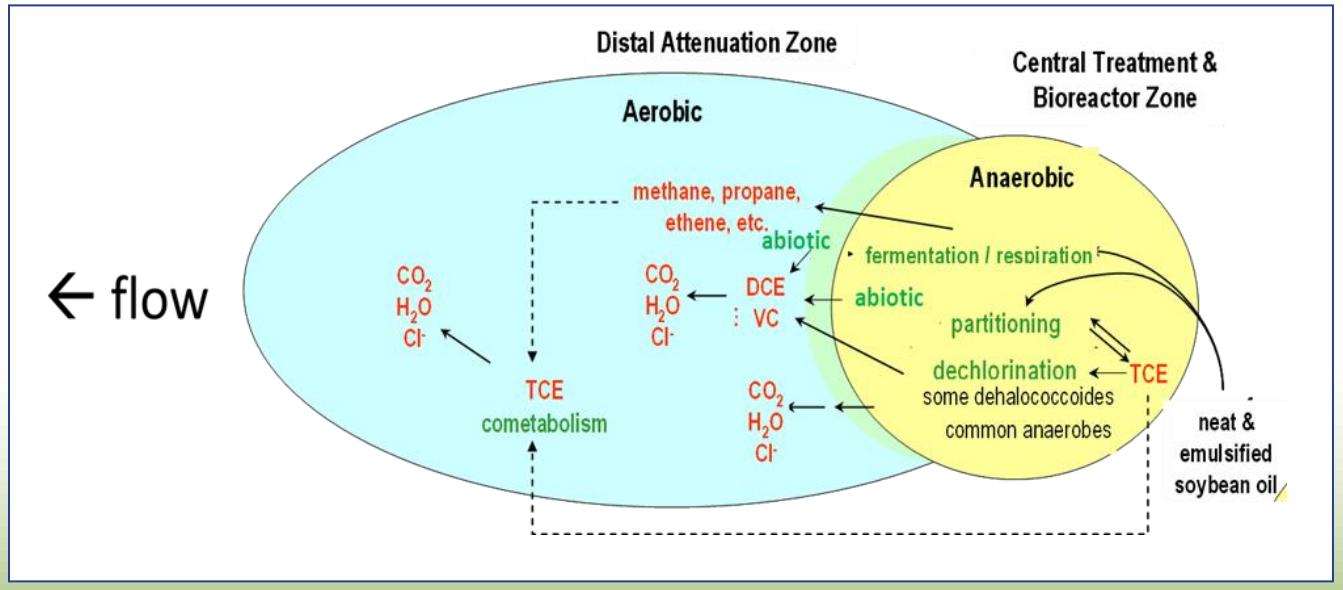
- Initiated three-year field demonstration
  - P&T system turned off
- Estimated maximum contaminant levels (MCLs) could be attained by 2027
- Selected EA using edible oils to create "structured geochemical zones" and support passive natural attenuation process for VOCs in soil and groundwater
- Demonstration goals include:
  - Minimize/suppress rebounding groundwater concentrations
  - Avoid plume expansion while P&T system is turned off
  - Meet remediation goals faster and reduce costs



(After Hazen 2010)

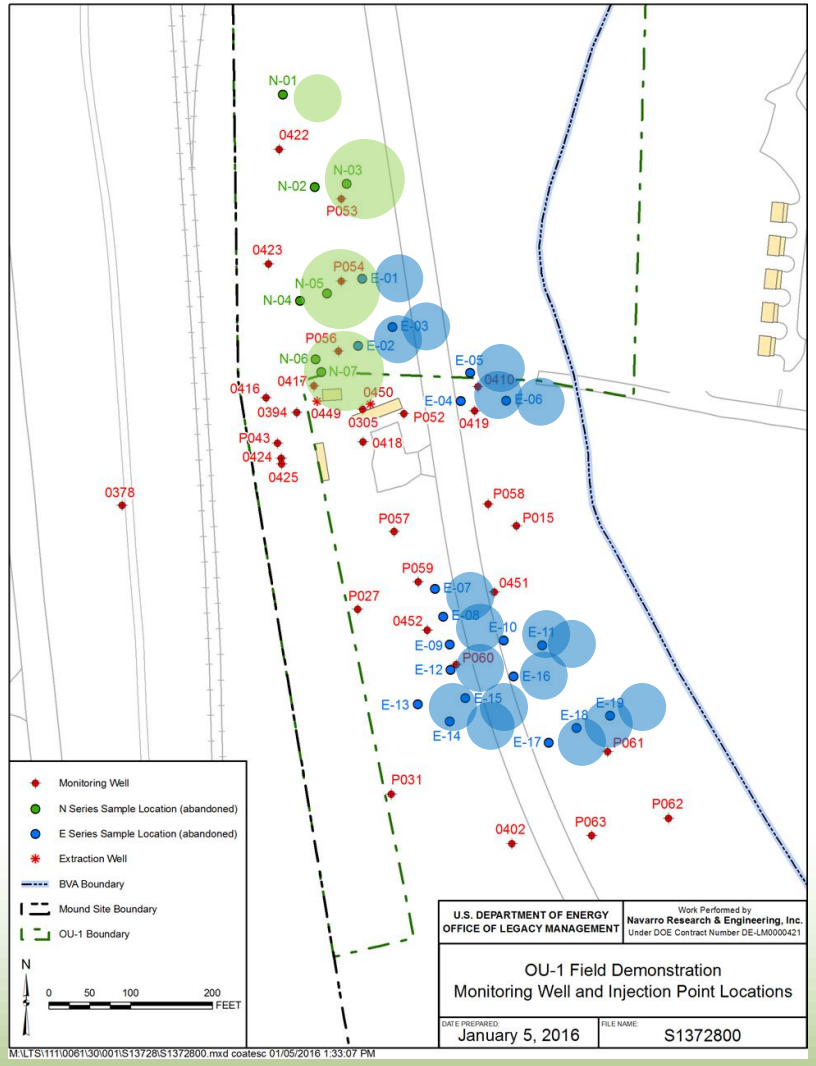
Design Approach

- Develop structured geochemical zones and decrease chlorinated VOC concentrations
  - Relies on groundwater flow through succession of anaerobic and aerobic zones
  - Anaerobic zones stimulate rapid degradation of parent compounds
  - Aerobic areas encourage rapid degradation of daughter products



Field Deployment

- Groundwater (E-series)
  - Flow paths originating from beneath former landfill
  - Groundwater impact area downgradient of former landfill
- Soil (N-series)
  - Areas with elevated PCE and TCE soil concentrations
- P&T system shut down
  - Auxiliary treatment system plan

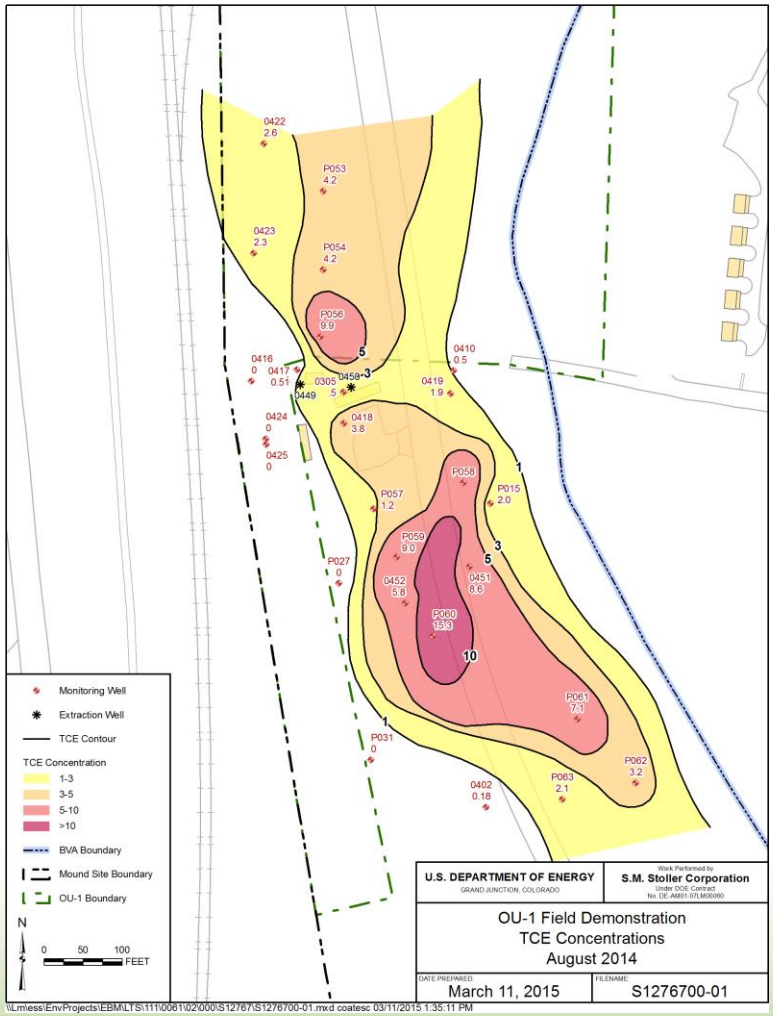


Field Deployment

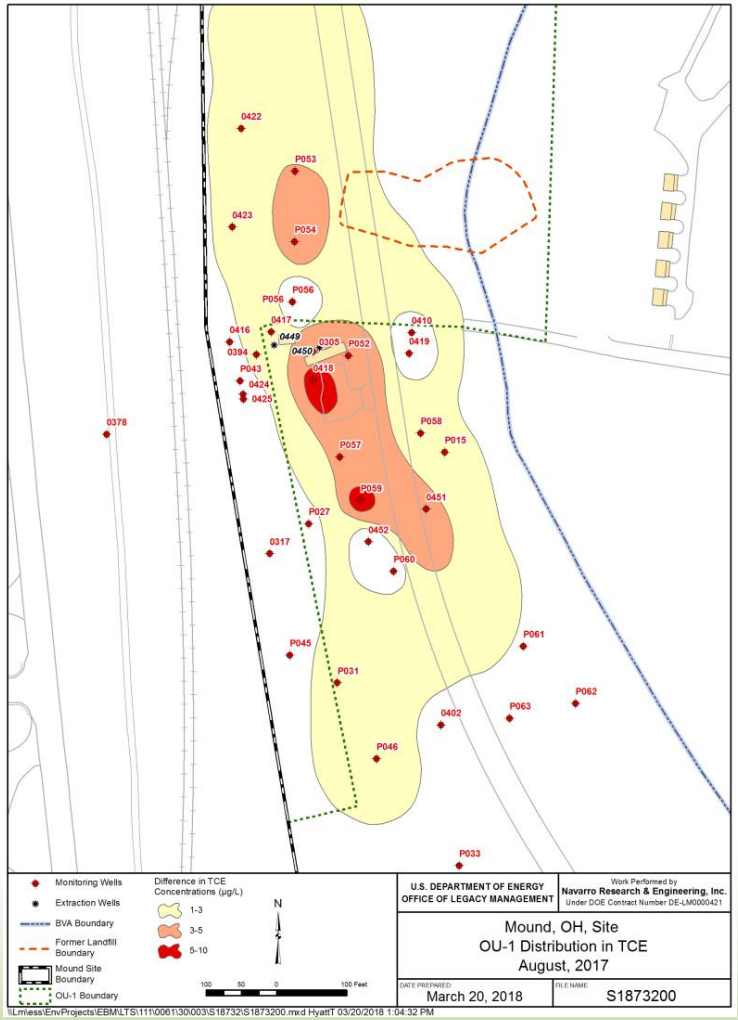
Data Analysis

- Utilize multiple lines of evidence to interpret data
  - Concentrations and mass of cVOCs
    - Monitoring and Remediation Optimization System (MAROS)
  - Aquifer geochemistry and other physical parameters
    - Oxidation-reduction potential, dissolved oxygen, other indicators
    - Groundwater flow, water levels, temperature
  - Microbial community and active enzymes
    - Generation of daughter products and structured geochemical zones
    - Quantitative Polymerase Chain Reaction (qPCR) of microorganisms
    - Identification of functional genes
- Compare data to USEPA Monitored Natural Attenuation Guidance

First Line of Evidence – VOC Concentrations

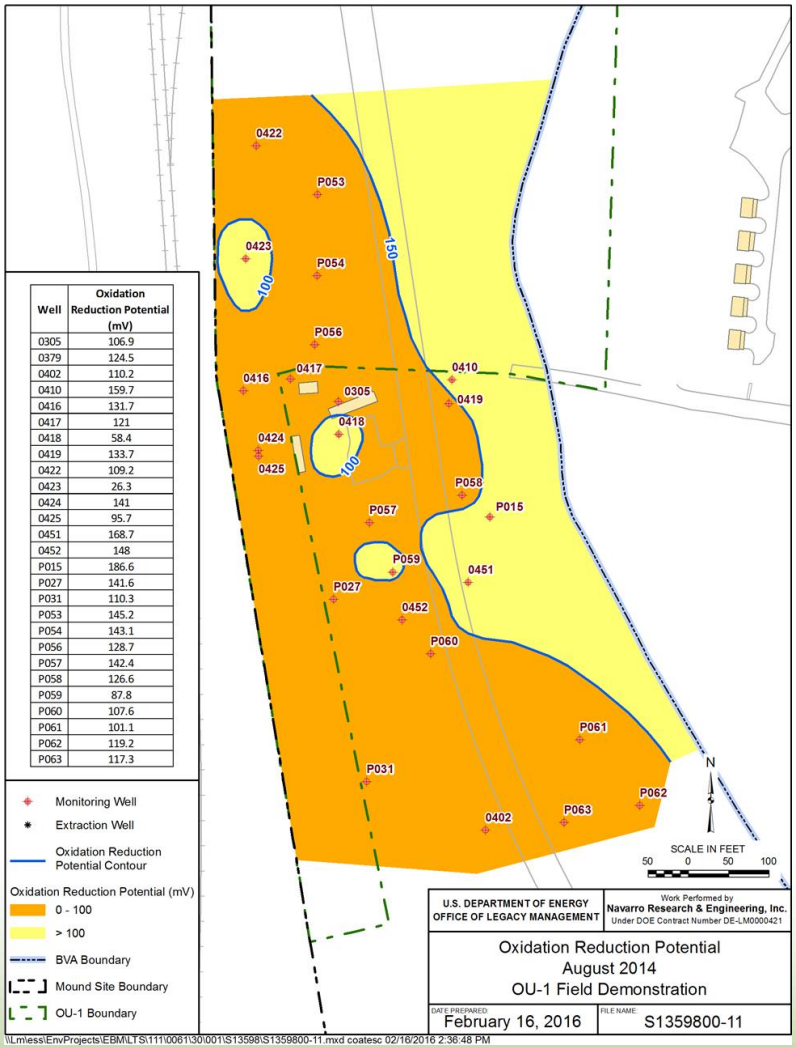


August 2014 Baseline - TCE

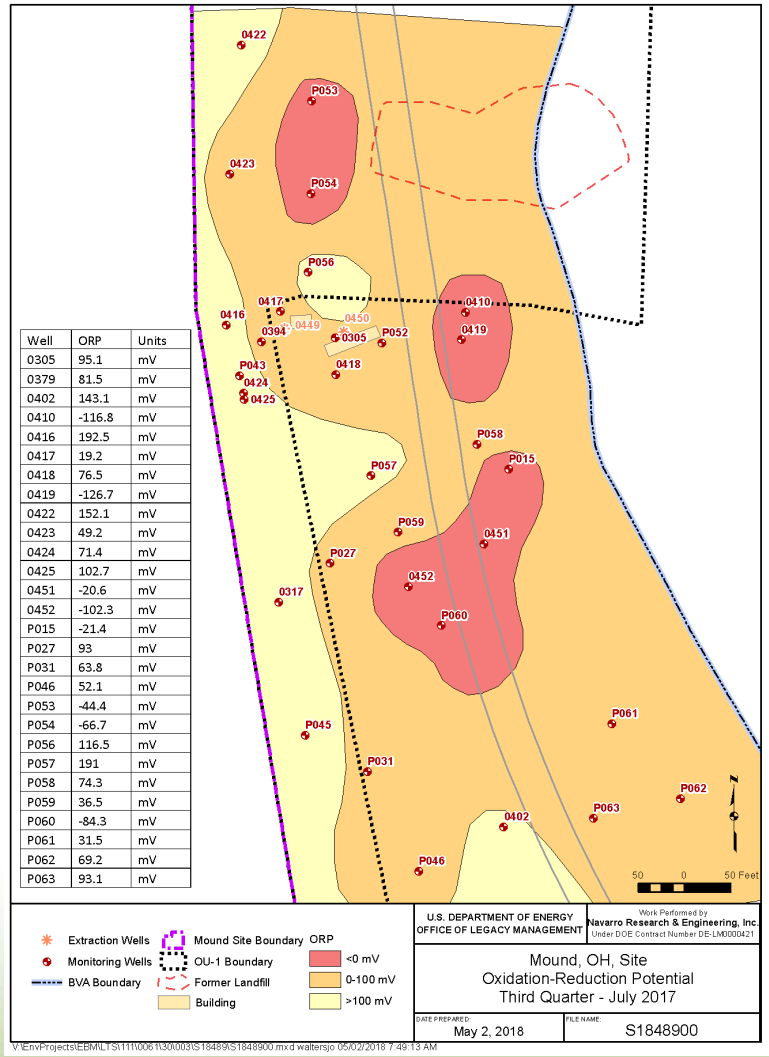


August 2017 Year Three - TCE

Second Line of Evidence - Geochemical



Well	Oxidation Reduction Potential (mV)
0305	106.9
0379	124.5
0402	110.2
0410	159.7
0416	131.7
0417	121
0418	58.4
0419	133.7
0422	109.2
0423	26.3
0424	141
0425	95.7
0451	168.7
0452	148
P015	186.6
P027	141.6
P031	110.3
P053	145.2
P054	143.1
P056	128.7
P057	142.4
P058	126.6
P059	87.8
P060	107.6
P061	101.1
P062	119.2
P063	117.3

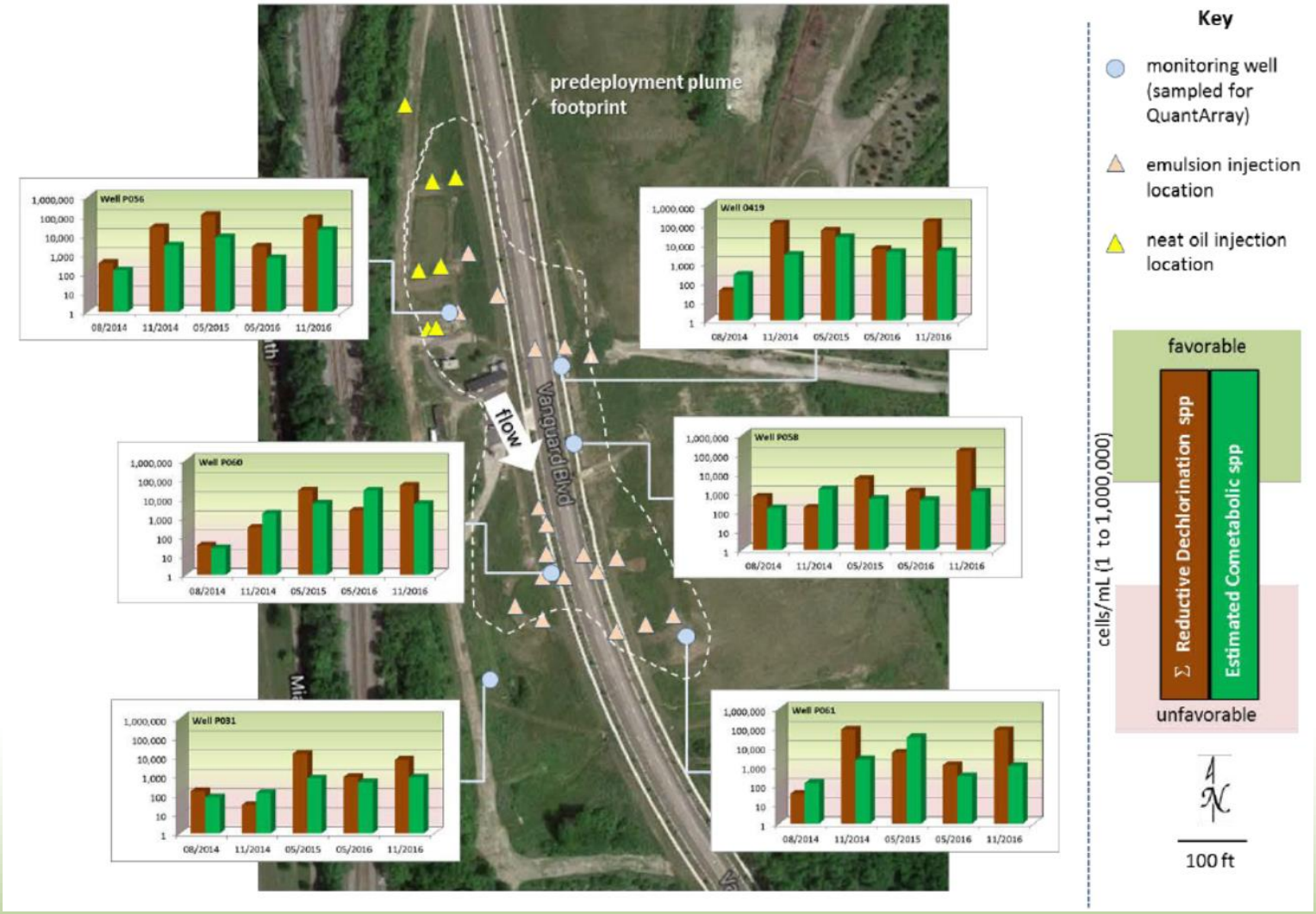


Well	ORP	Units
0305	95.1	mV
0379	81.5	mV
0402	143.1	mV
0410	-116.8	mV
0416	192.5	mV
0417	19.2	mV
0418	76.5	mV
0419	-126.7	mV
0422	152.1	mV
0423	49.2	mV
0424	71.4	mV
0425	102.7	mV
0451	-20.6	mV
0452	-102.3	mV
P015	-21.4	mV
P027	93	mV
P031	63.8	mV
P046	52.1	mV
P053	-44.4	mV
P054	-66.7	mV
P056	116.5	mV
P057	191	mV
P058	74.3	mV
P059	36.5	mV
P060	-84.3	mV
P061	31.5	mV
P062	69.2	mV
P063	93.1	mV

August 2014 Baseline - ORP

July 2017 Year Three - ORP

Third Line of Evidence – Microbial



Summary of Results (2014-2017)

- Dissolved PCE and TCE plumes continue to decrease in size and mass
- Statistical tests indicate the concentrations of the parent constituents continue to decrease in majority of wells
- Biochemistry and microbial community within structured geochemical zones appear to be stable
- Drought and local dewatering project caused disruption in year 2 data
  - Extend study one year to collect additional data

Cleanup Time Frames		
P&T System	Baseline	2040
EA Field Demonstration	Projected	2027
	End of Year 1 (2015)	2020 – 2025
	End of Year 2 (2016)	2021 – 2037
	End of Year 3 (2017)	2021 – 2027

Enhanced Attenuation – The Path Forward

- Are contaminants likely to be addressed by natural attenuation processes?
- Will the plume remain stable and hydraulically contained?
- Any potential for unacceptable risk from the contamination?
- Analyze year four data
- Compare to EPA MNA Guidance
- Issue final summary report
- Engage EPA and Ohio EPA in discussions on remedy change