verdantas

Tuesday, June 4, 2024

Optimizing the Remedial Approach to Accelerate the Remediation Timeline While Managing Client Expectations: Remediating a Complex Former Manufacturing Site

Zackary Smith, LEP, Alison Kokorsky, LSRP, and Jonathan Wood, Verdantas

Ravi Srirangam, P.E., Ph.D., Ramboll

Fayaz Lakhwala, Ph.D., Evonik

verdantas

Acknowledgements

Outline

- Site Background
- Conceptual Site Model
- Source Area Excavation and Site Constraints
- Combined Remedies Approach
- Post-Injection Concentration and Geochemical Trends
- Site Challenges **and Further Work**
- Conclusions

Site Background

Former Manufacturing Facility Northern NJ

Currently Light Manufacturing

P&T System, ZVI Slurry Wall (1990s)

Excavation (1M$) (2019)

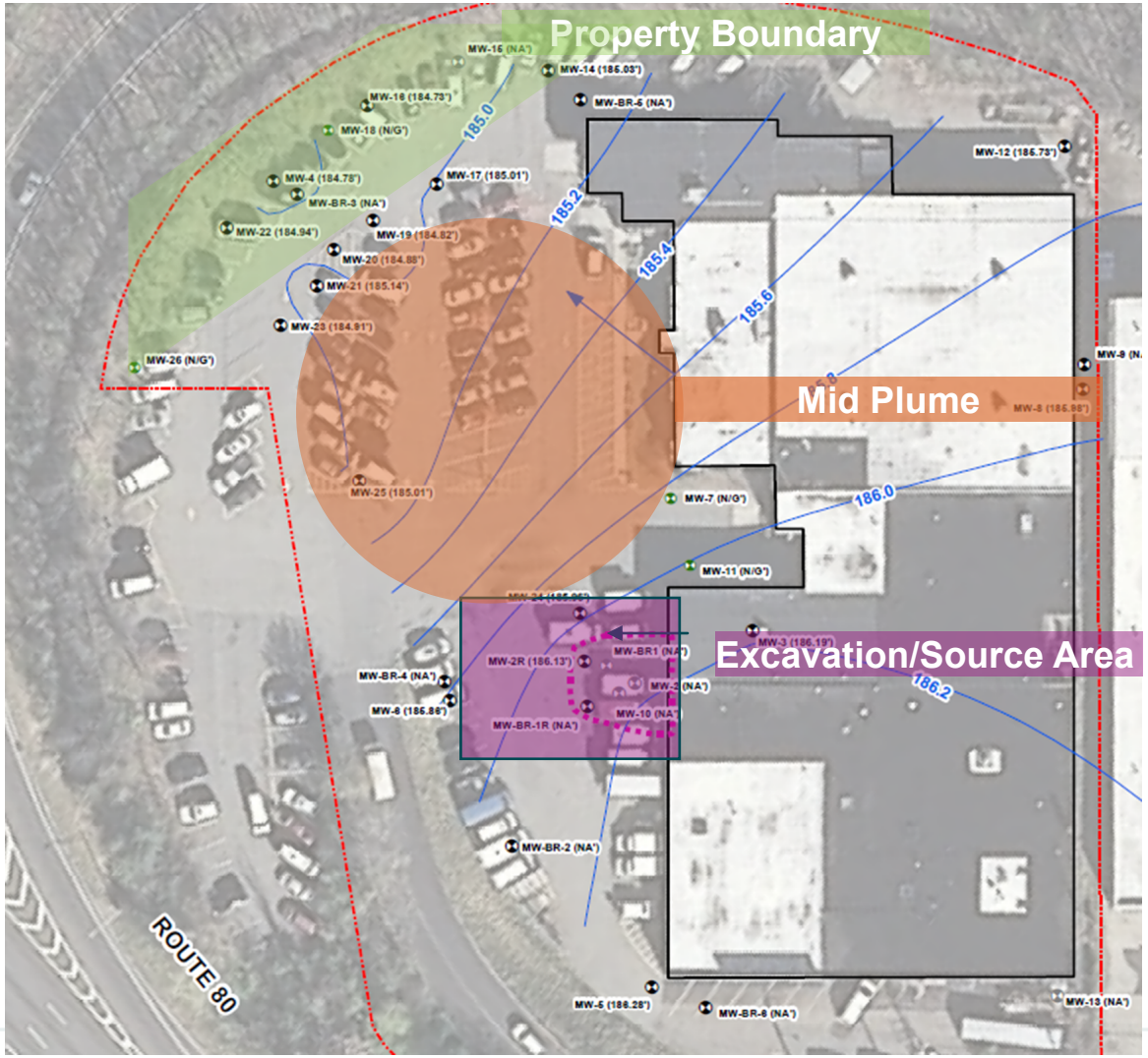
Source Area CVOC Concentrations > 300 mg/L

Primary Contaminants:

- Chlorinated Ethenes
- Residual Chlorinated Ethanes

Site Footprint

MW-23	(5/13/20)	(11/11/20)	(5/25/21)
1,1,1-TCA:	ND	ND	ND
1,1-DCA:	30 J	ND	14 J
1,1-DCE:	93 J	12 J	43
Benzene:	ND	ND	ND
CIS-DCE:	13000	2600	7900
TRANS-DCE:	44 J	9.5 J	21
PCE:	ND	ND	7.9 J
TCE:	35000	4600	13000
Toluene:	ND	ND	ND
VC:	410	10	150
1,4-Dioxane:	6.8	ND*	ND*



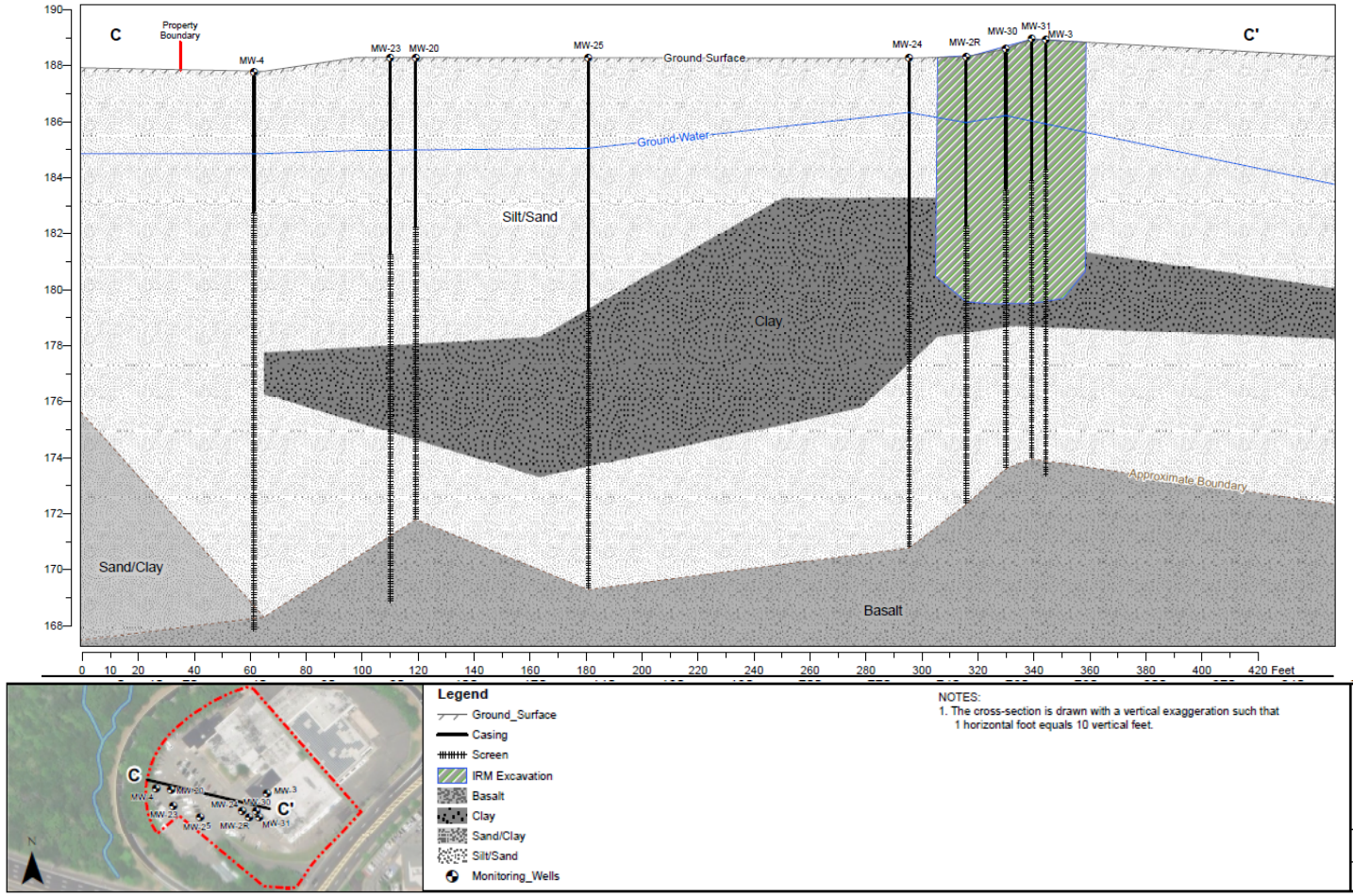
MW-4	(5/13/20)	(8/11/20)	(11/10/20)	(5/25/21)
1,1,1-TCA:	ND	ND	ND	ND
1,1-DCA:	ND	1.4 J	2.7 J	ND
1,1-DCE:	30	9	18	11
CIS-DCE:	4900	1800	3100	1700
TRANS-DCE:	17 J	5.9	9.8 J	4.7 J
PCE:	ND	ND	ND	ND
TCE:	7200	1400	3400	2400
Toluene:	ND	ND	ND	ND
VC:	360	110	160	59
1,4-Dioxane:	8.2*	ND	11*	ND

MW-24	(5/12/20)	(8/11/20)	(11/11/20)
1,1,1-TCA:	ND	ND	ND
1,1-DCA:	ND	ND	ND
1,1-DCE:	400 J	430 J	410 J
CIS-DCE:	61000	74000	100000
TRANS-DCE:	300 J	300 J	300 J
PCE:	360 J	380 J	370 J
TCE:	330000	330000	320000
Toluene:	ND	ND	ND
VC:	640 J	650 J	750 J
1,4-Dioxane:	ND	ND	ND

Conceptual Site Model

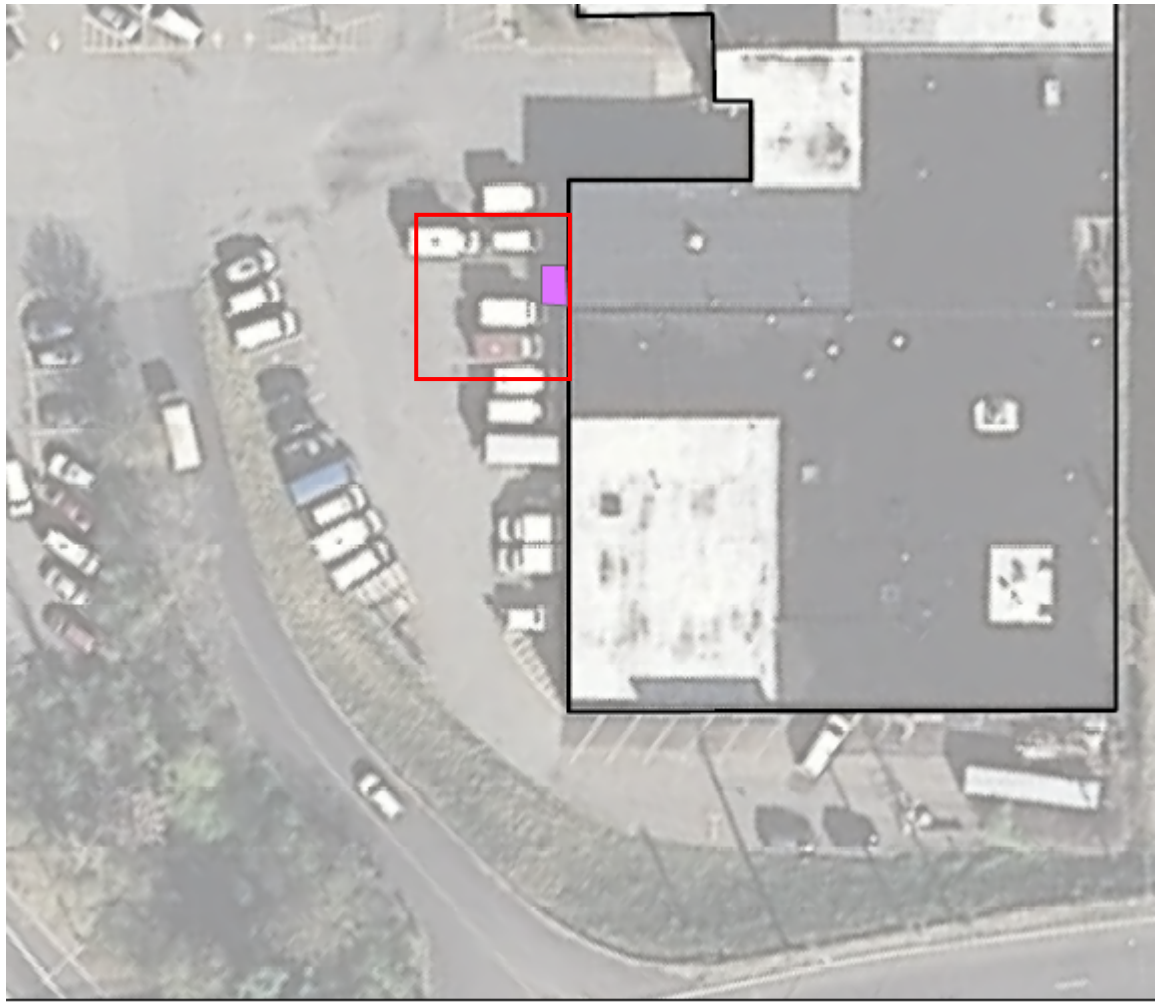
Geology

- Overburden soils consist of glacial lake bottom sediments and till including silt, fine sands, and clay. Very low permeability due to prevalence of fine material. Groundwater flow calculated to travel at approximately 10-50 ft/yr.
- Groundwater in the overburden is encountered at approximately 2 ft – 5 ft bgs across the Site and flows to the Northwest
- Bedrock in the area of the Site consists of dark gray basalt (volcanic rock) of the Preakness Formation. Areas of weathered bedrock observed approximately 10 ft into bedrock, followed by more competent rock

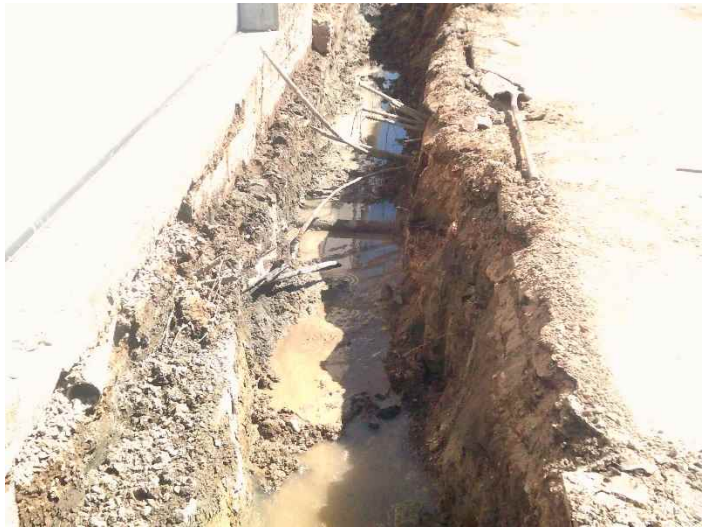


Source Area Excavation

- Remedial excavation performed surrounding area of former soil removal
- Goal to remove contaminant source mass
- Excavation limits based on 100 ppm TCE in soil
- Constraints and complications encountered during soil excavation
- Significant component of integrated remedial strategy

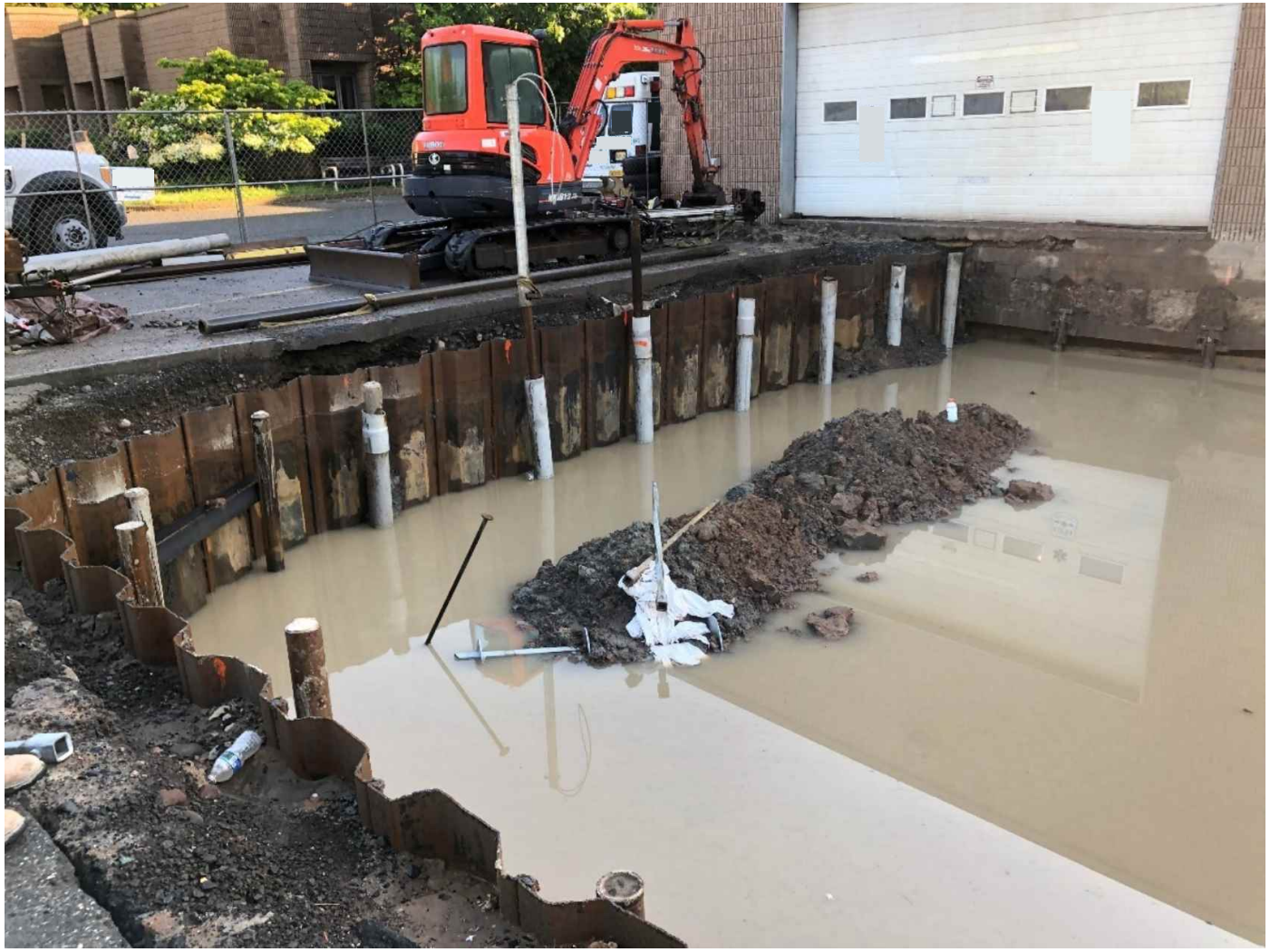


Source Area Excavation

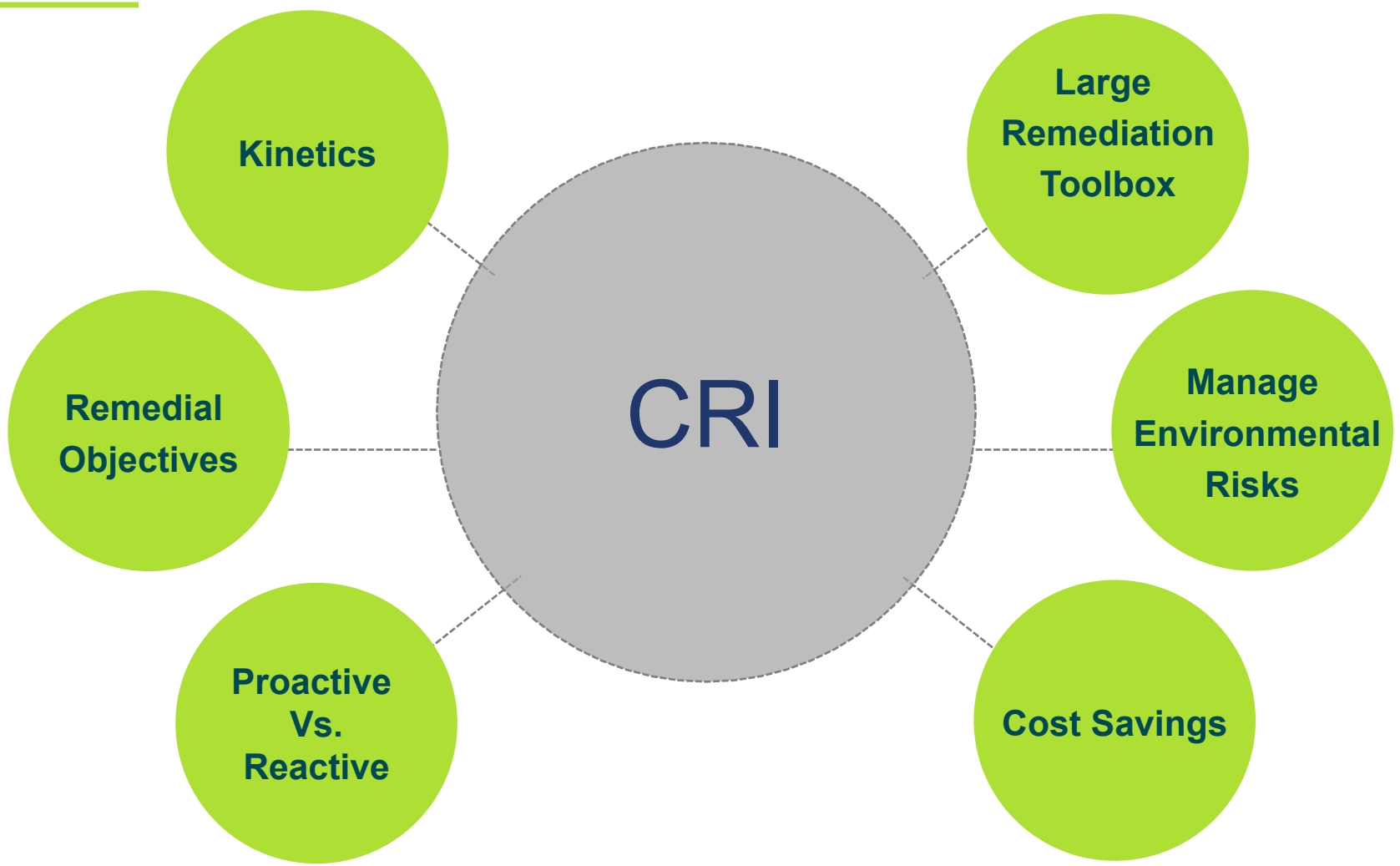


Typical Morning Conditions

- Above-average seasonal precipitation / water levels
- Extensive dewatering required daily
- Significant expense and logistical constraint
- Remediation executed successfully through careful planning and consideration of dewatering constraints and other constraints



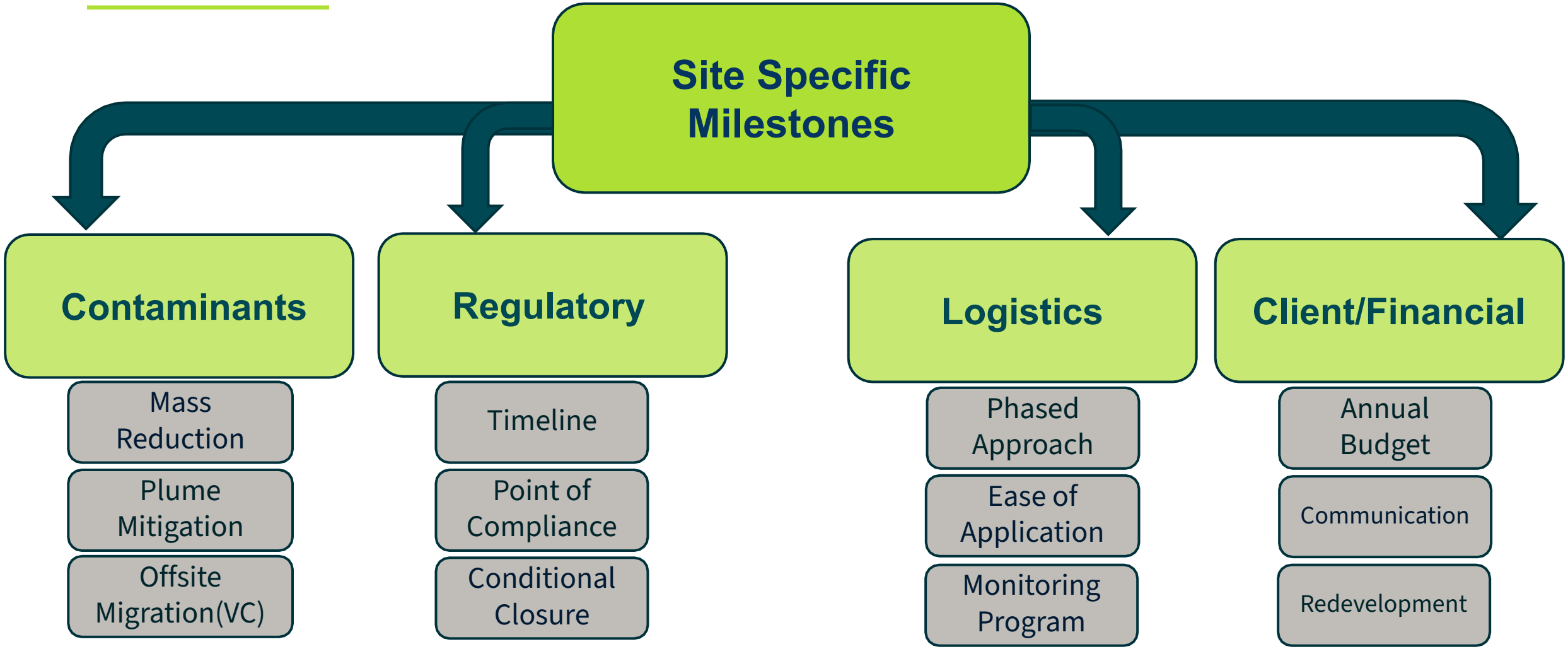
Transition to In-Situ Remediation - Combined Remedies Initiative (CRI)



Combined Remedies – ISCO to ISCR/ISBGT

ISCO	ISCR/ISBGT
▶ Reduce source mass by orders of magnitude ▶ Focused Injection Application ▶ pH above 12.5 s.u. persist in the source area within the sheeting from the 2019 excavation ▶ Will address 1,4-Dioxane ▶ Residual sulfate paves way for transition into ISCR/ISBGT reagents ▶ Soluble reagents (Klozur® SP) pose fewer injection challenges	▶ Not 100% contact dependent - can be effective over a wider area ▶ ISBGT mechanisms lasts for years. ▶ Solid Reagents (slurry) increases injection time and pose challenges with surfacing in shallow aquifers. ▶ CRI accelerates remediation timeframe

Objectives for MNA Transition



ISCO Injection Program (Nov 2021- Nov 2023)

KLOZUR® SP

ISCO- Alkaline activated sodium persulfate

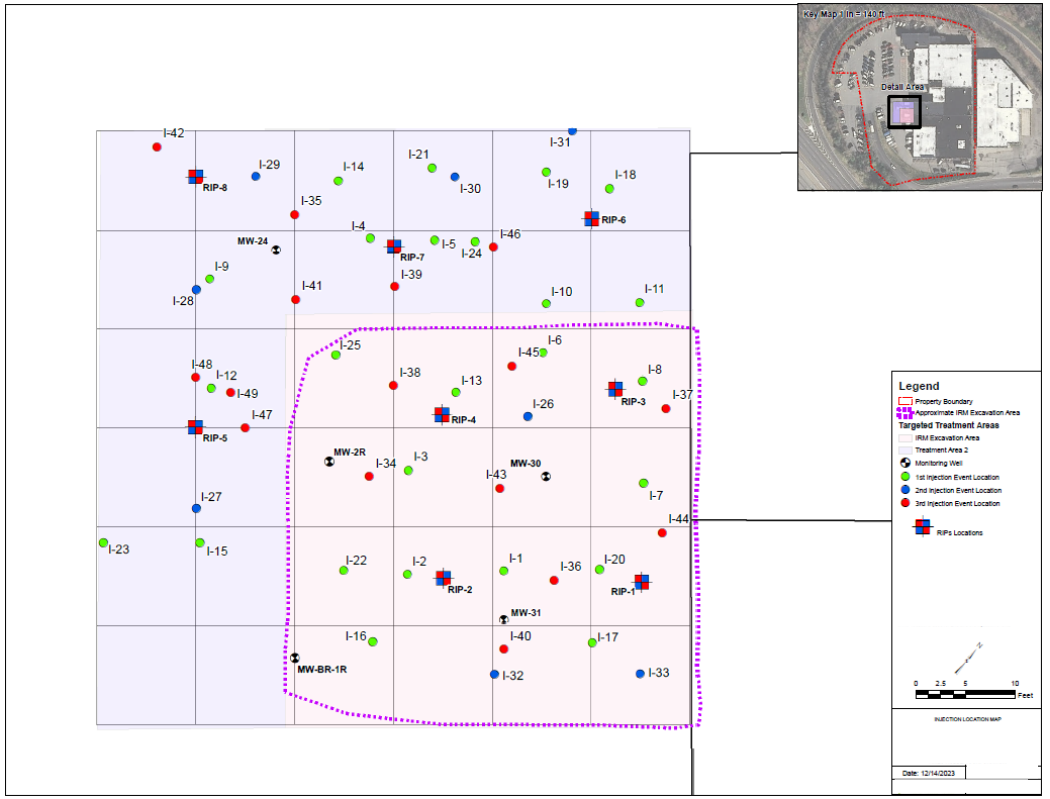
3,000 ft² area targeting 6-13 ft bgs

Three applications (Nov 2021, May 2022 and October 2023)

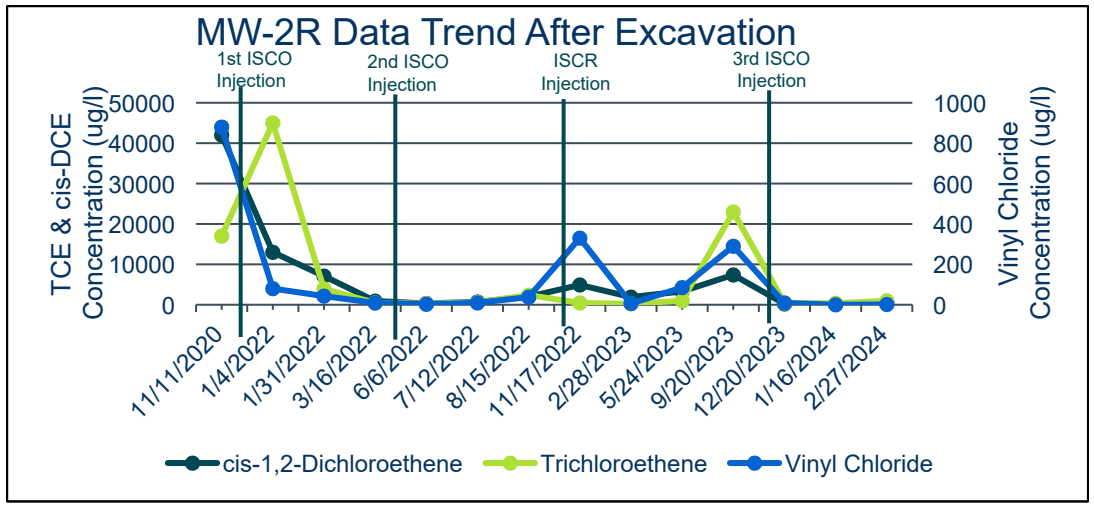
Injection concentration 198-228 g/L targeting 24% PV

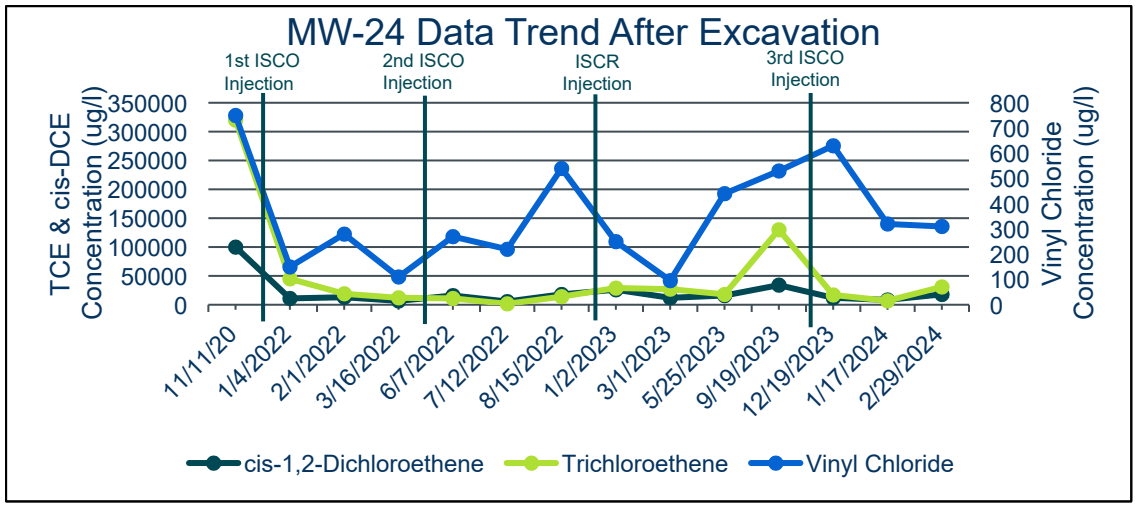
Hybrid Injection Approach (DPT/RIP)

Monthly Monitoring for CVOCs and Geochemical Signature Data



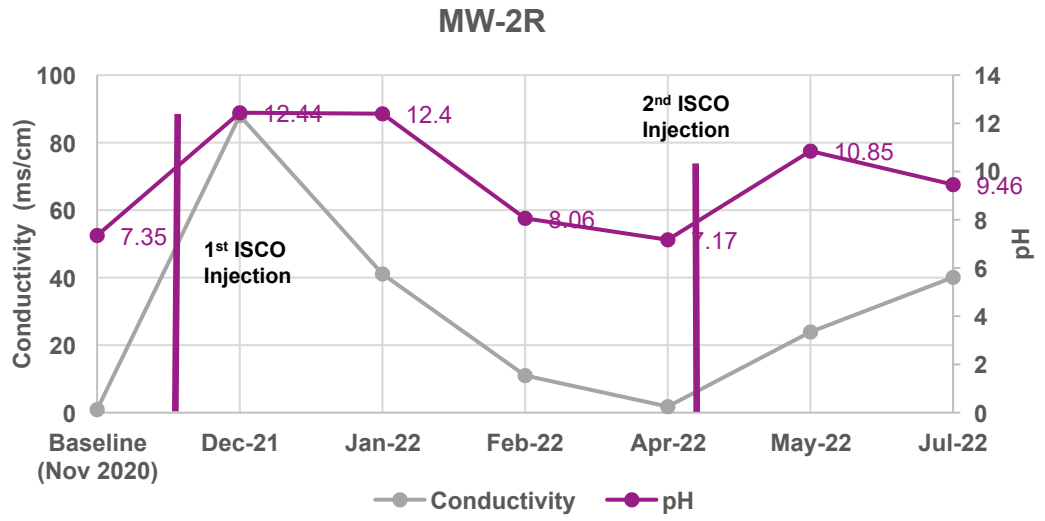
ISCO-Post Monitoring Trends

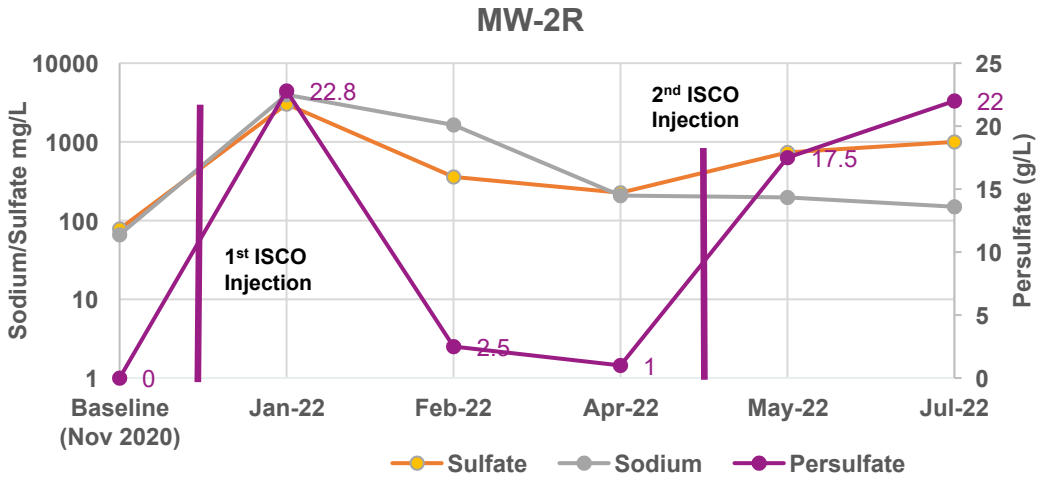


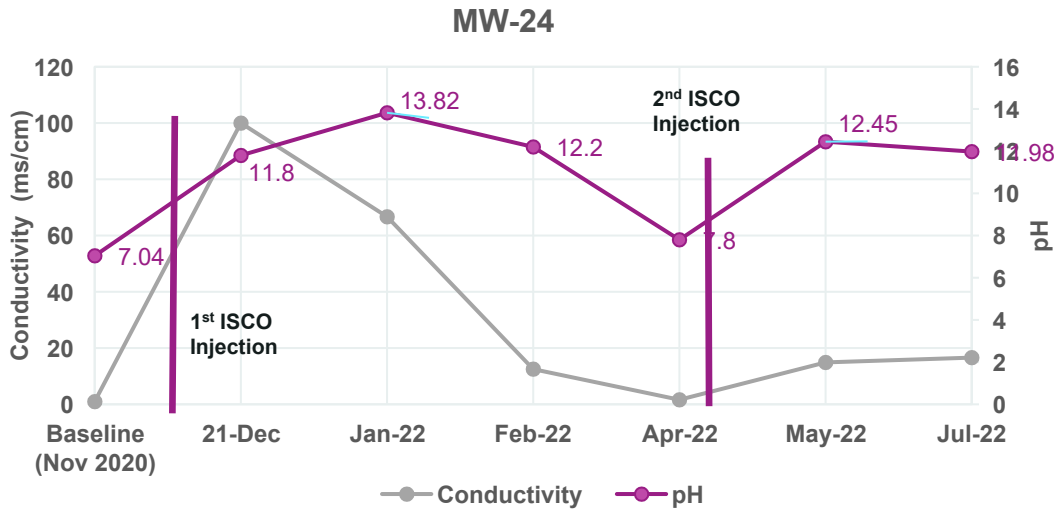


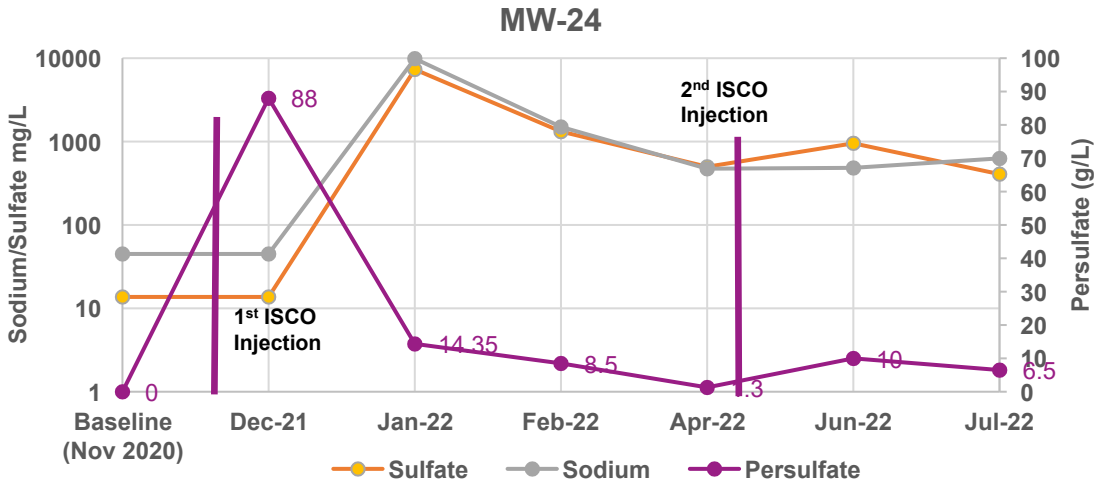
TCE Soil Sampling (ppm)	Pre-Injections	Post 1st ISCO	Post 2nd ISCO
SB-1A	6,100	47	1,100
GP-18 (15)	4,510	660	310
S-9 (12.5)	8,720	0.8	---
S-9 (15)	5,690	4.8	---
S-3 (13.5)	6,900	400	1,500
S-4 (13)	1,100	18	---
S-5 (12) EMSL	16,000	50	3.4

ISCO-Geochemical Signature







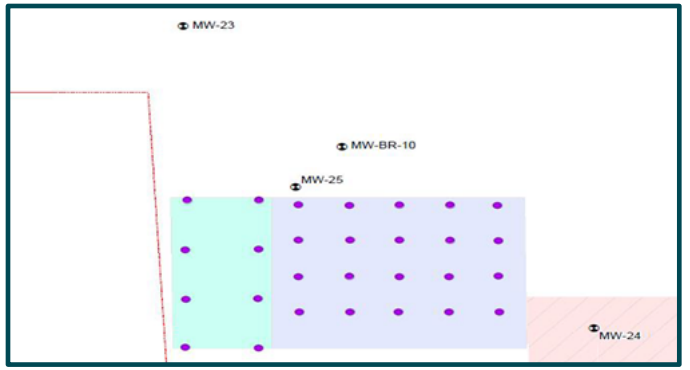


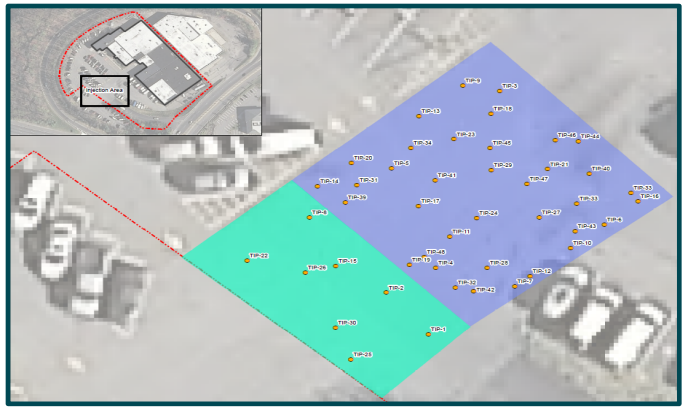
ISCO: Material +Injection costs 130K USD or 6$/ft³

ISCR/ISBGT Injection Program (Oct 22)

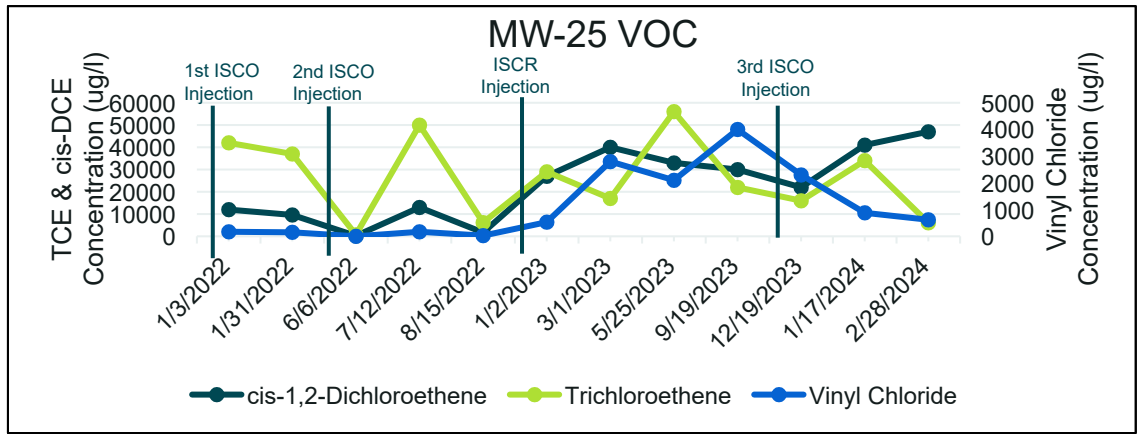
EHC® Reagent | GeoForm® Biogeochemical | ELS® Microemulsion

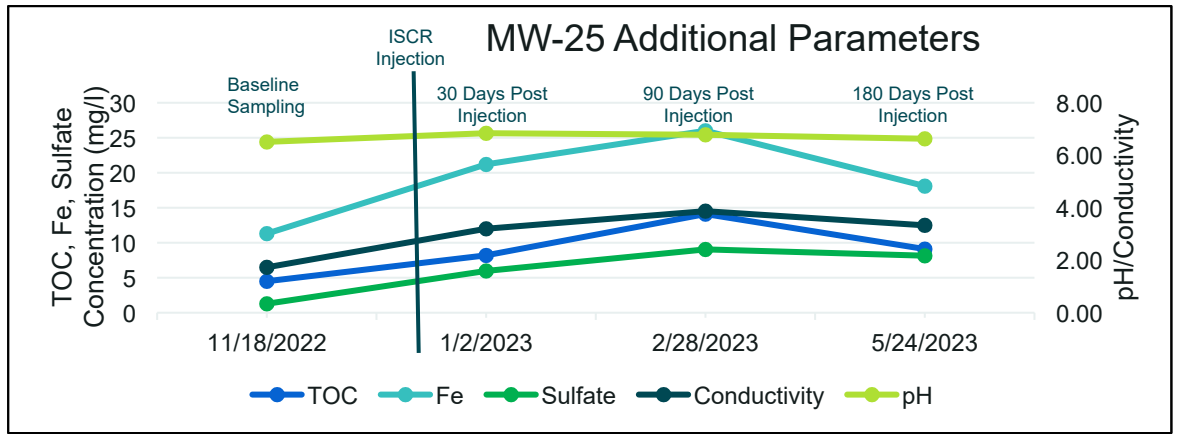
Insitu Biogeochemical Transformation (ISBGT)
3,000 ft² area targeting 6-13 ft bgs
15,200 lbs. EHC 3360 lbs. 25% ELS and 265 lbs. Geoform Soluble Mix
Application rate EHC 0.15% , ELS 3000 mg/L
Direct Push Injection Approach (22 days)
Quarterly Monitoring for CVOCs and Geochemical Signature Data

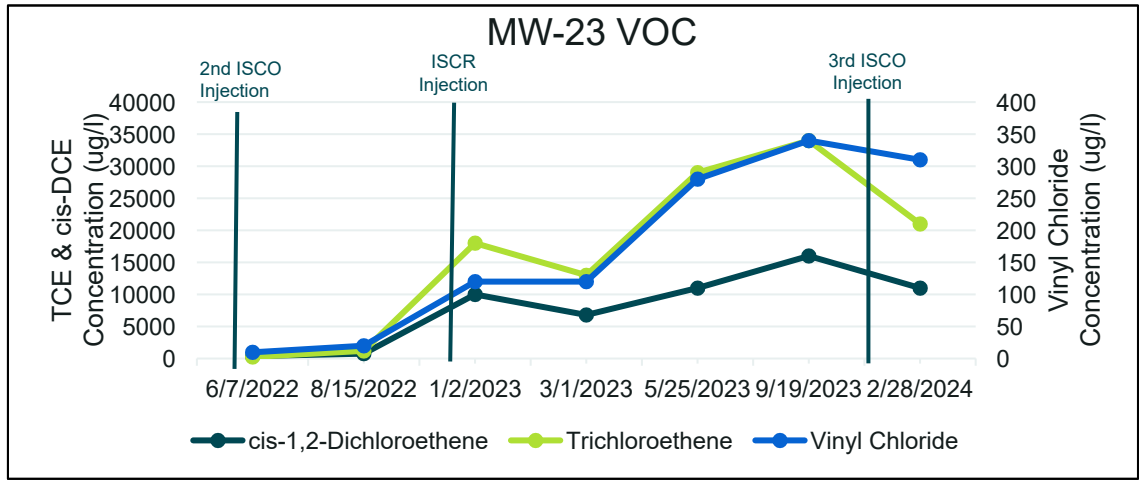


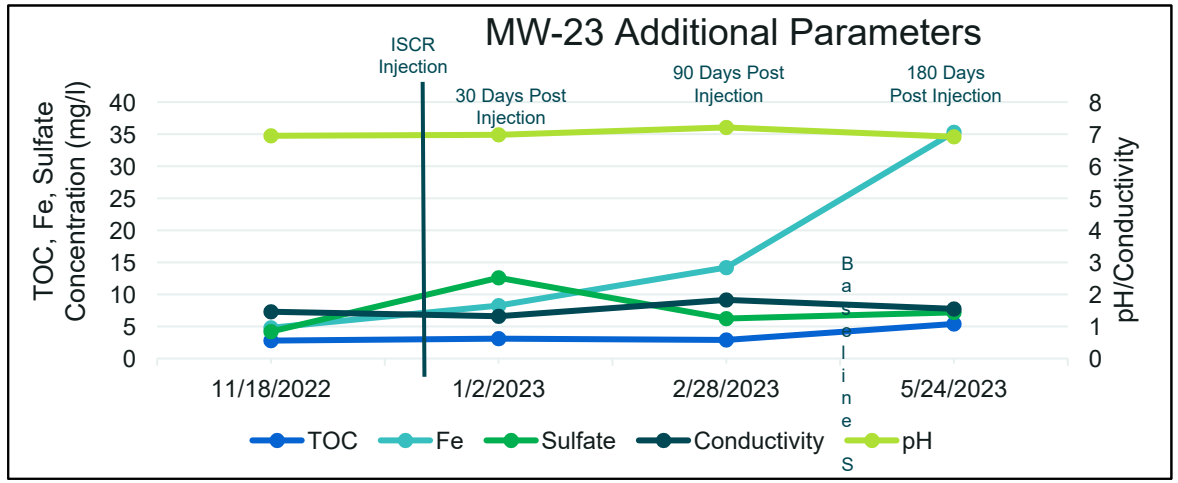


ISCR/ISBGT- Results and Discussion









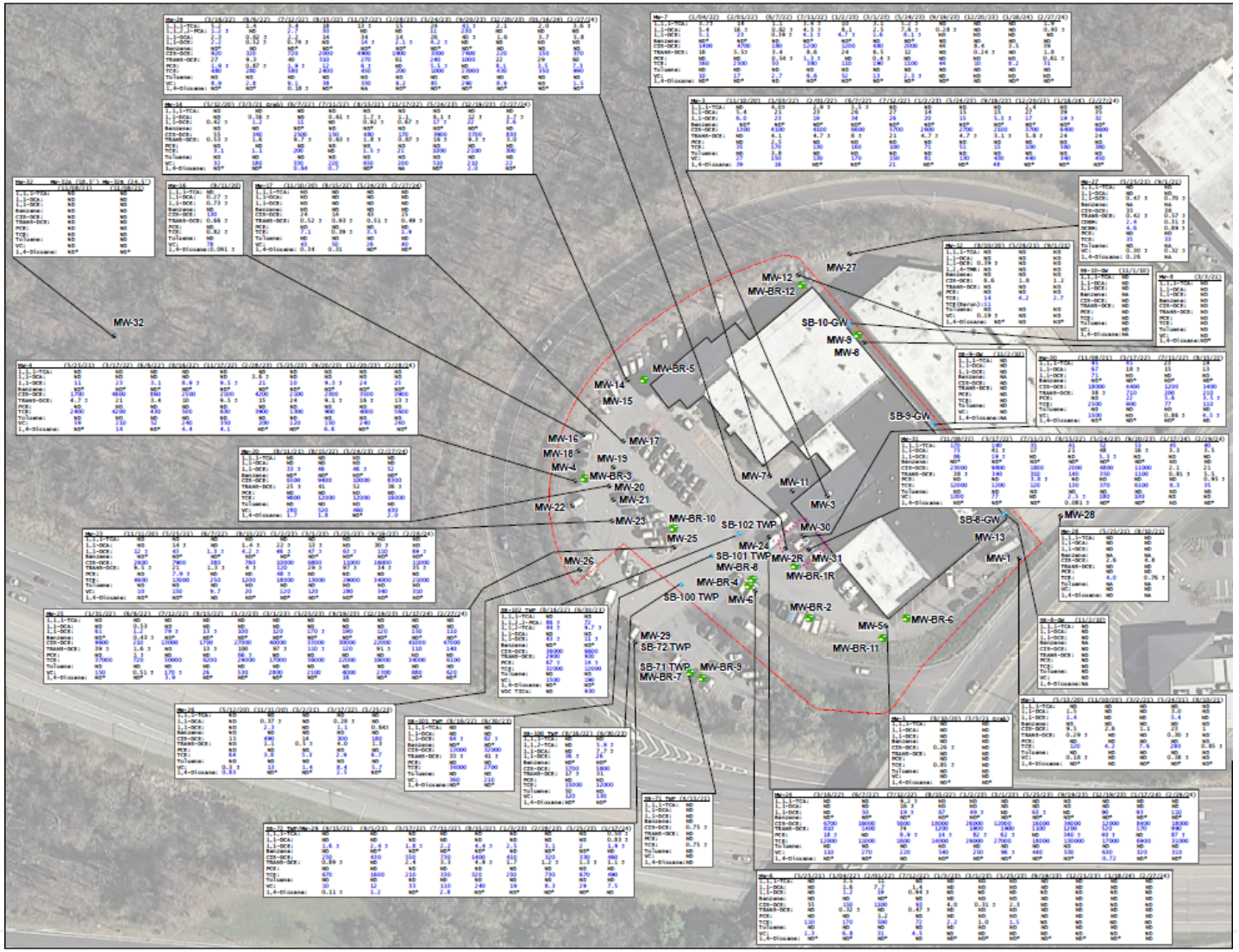
ISCR: Material + Injection Costs 150K USD or 4.7$/ft³

Site Status for MNA Transition

- Achieved orders of magnitude (OOMs) reduction in contaminant/source area mass
- Shift in geochemical conditions to support the next step in the CRI treatment strategy
  - Source Area - additional ISCO injection – transition not demonstrated
  - Mid Plume (implemented reductive technologies)
- Downgradient area- Planned reactive barrier downgradient to prevent any migration of residual CVOCs (i.e., cis-1,2-DCE or VC)

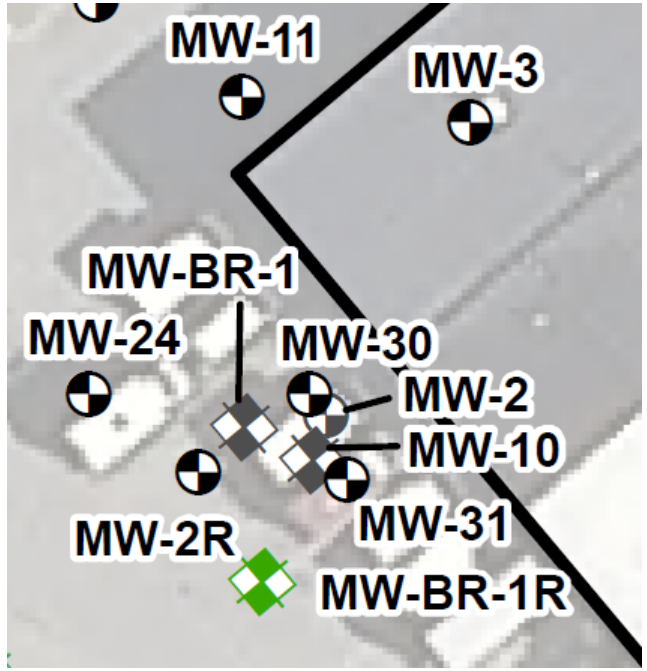
In Situ Response and CSM

- Anticipated outcome was achieved in most monitoring wells on Site
- Focus on select well near excavation area
- Back to CSM



Representative Well

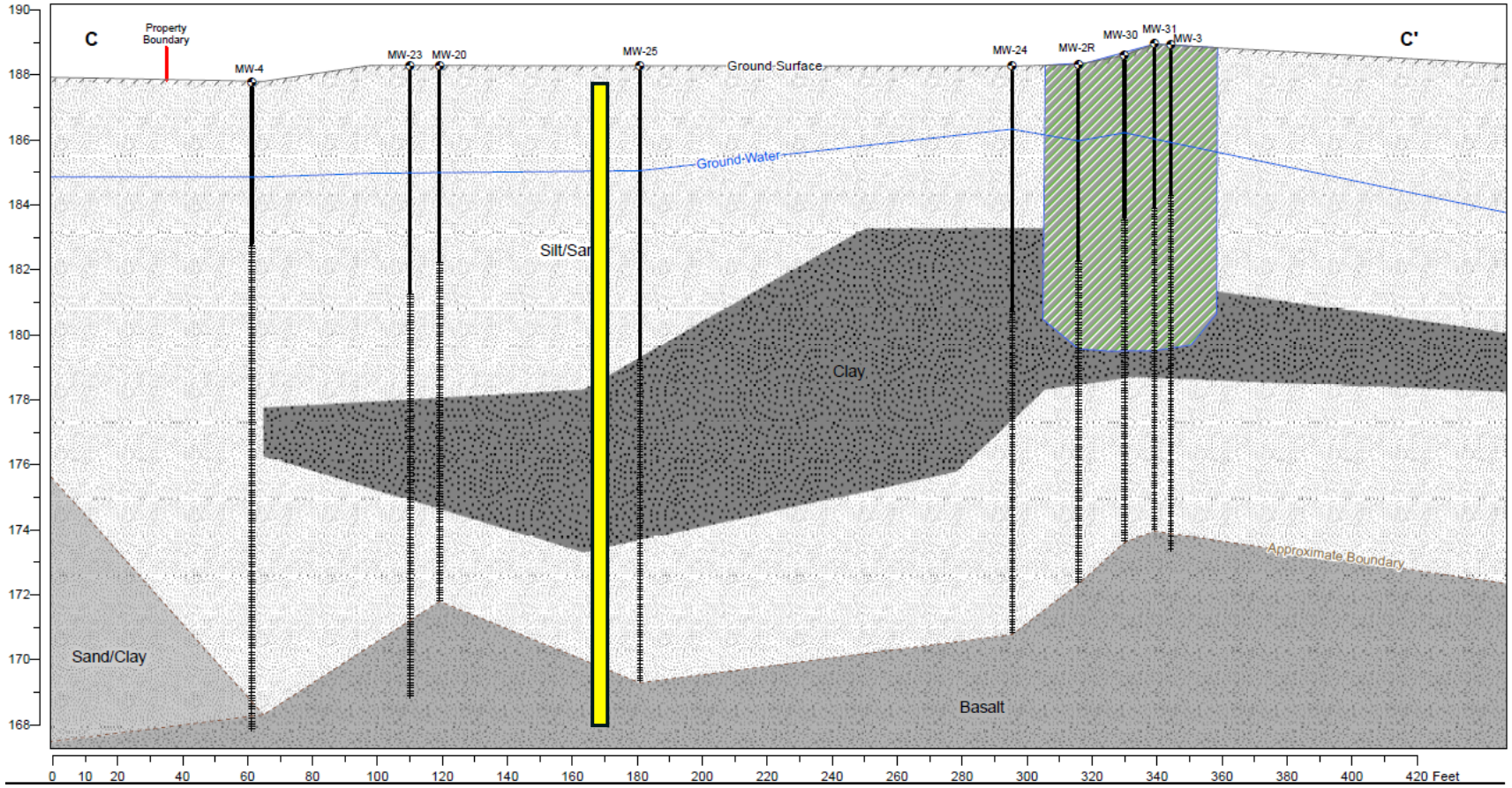
- Representative of monitoring wells at overburden-bedrock interface
- Logistics made this a potentially difficult horizon to fully characterize



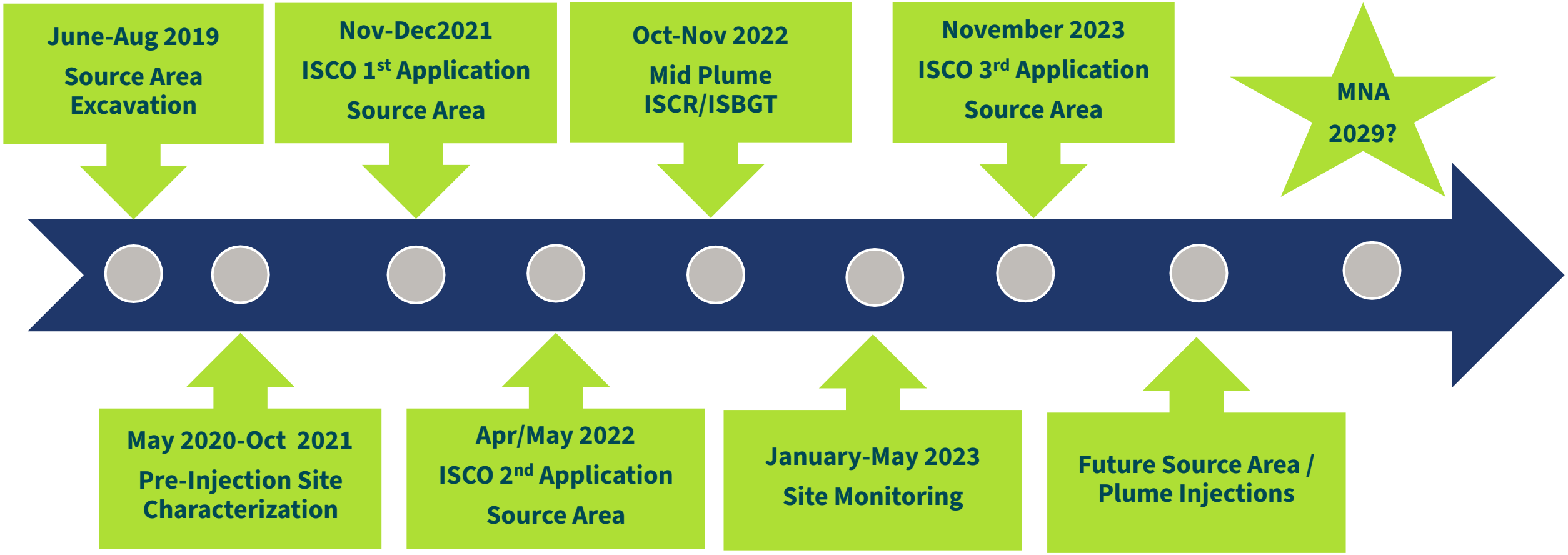
MW-24	(3/16/22)	(6/7/22)	(7/12/22)	(8/15/22)	(1/2/23)	(3/1/23)	(5/25/23)	(9/19/23)	(12/19/23)	(1/17/24)	(2/29/24)
1,1,1-TCA:	ND	ND	9.2 J	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DCA:	ND	ND	16 J	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DCE:	ND	50	19 J	67	49 J	ND	63 J	ND	90	93	110
Benzene:	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*
CIS-DCE:	6700	16000	5600	18000	26000	12000	16000	34000	12000	8400	18000
TRANS-DCE:	810	1400	74	1200	1900	1900	1100	1200	520	170	990
PCE:	18 J	ND	8.9 J	14 J	82 J	62 J	ND	340 J	40 J	ND	87 J
TCE:	12000	11000	1600	14000	29000	27000	18000	130000	17000	6900	31000
Toluene:	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VC:	110	270	220	540	250	96 J	440	530	630	320	310
1,4-Dioxane:	ND*	ND*	ND	ND*	ND*	ND*	ND*	ND*	0.72	ND*	ND*

Focused strategy on overburden/bedrock interface

- Targeted weathered bedrock re-injectable points (RIPs). Currently in investigation and design stage.
- Aquifer testing – determine hydraulic properties and radius of influence.
- Further understanding of the CSM through additional investigation



Timeline of Remediation



Findings and Path Forward

- Integrated remediation strategy, such as excavation, CRI, and MNA offers best approach for real-world sites
- Need to be adaptable for complex sites
- Plans are developed using information available. At every stage of an investigation/remediation, must evaluate data and continually refine the CSM
- Importance of communicating progress and updated strategies to stakeholders, including clients and regulators

verdantas

ISCO

ISCR/ISBGT

Thank You