Successful In Situ Pilot-Scale Test Design and Implementation to Treat Groundwater Impacted with PCE and TCE through Organic Carbon and Soluble Iron Injections

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THE ELEVENTH INTERNATIONAL CONFERENCE ON
REMEDIATION OF CHLORINATED AND RECALCITRANT COMPOUNDS
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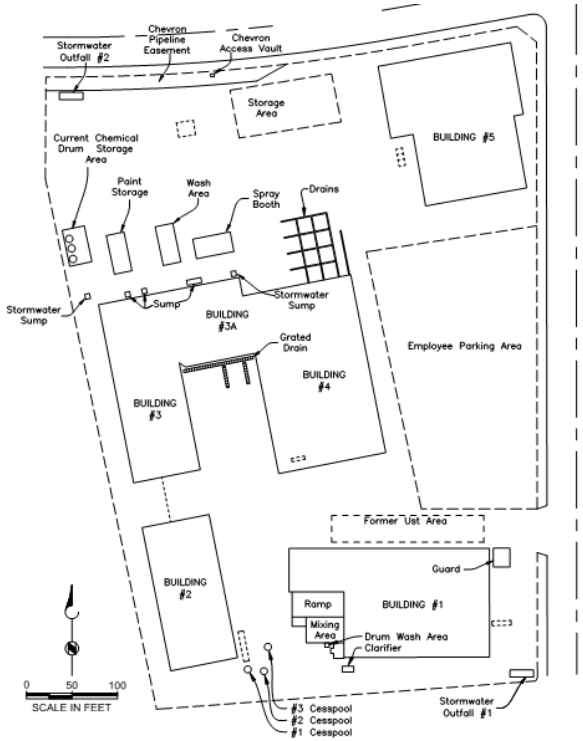
PALM SPRINGS, CALIFORNIA

Agenda

- General Site History and Information
- Preliminary RAP and Feasibility Study
- Pilot Test Objectives
- Well Installation Design and Amendment Details
- Pilot Test Results and Conclusions
- Full Scale Design Considerations

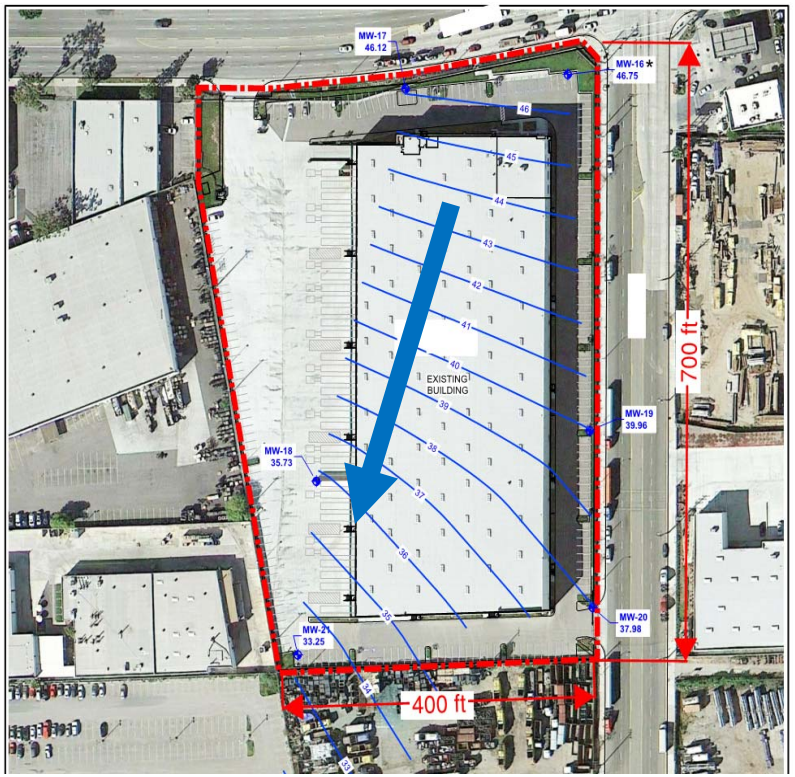
Site History

- 7-acre Site with multiple buildings.
- Historic manufacturing activities in late 1900s.
- Redeveloped in 2007 as one warehouse building with a vapor barrier, surrounded by parking.
- Located in a mixed industrial/commercial area in south Los Angeles County.



Geology/Hydrogeology of Injection Zone

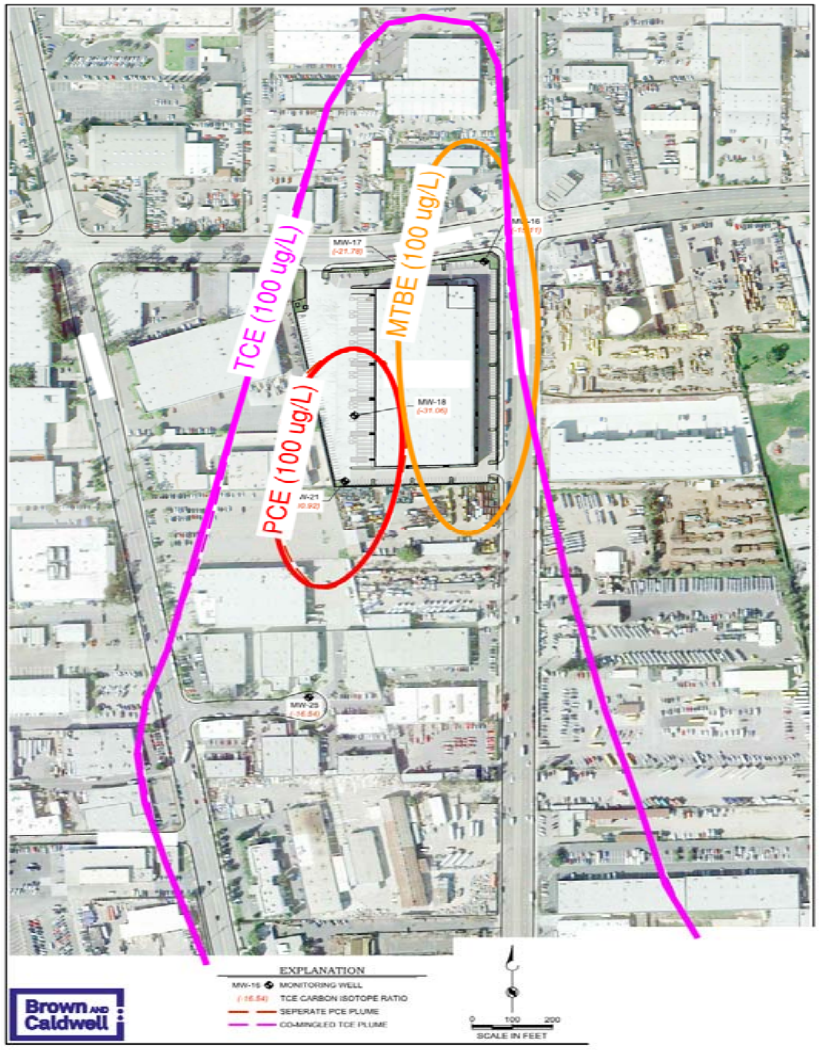
- Targeted Injection WBZ – 70 to 85 feet bgs
- Soil Type – Silty Sand (Porosity 30-40%)
- Flow Direction – South/Southwest
- Flow Velocity (at MW-18) – 25 feet/year



Soil Remediation/Groundwater Assessment

- Source Area soil was primarily impacted with PCE
  - o Soil Removal and SVE from 2005 – 2007
  - o Groundwater Monitoring from 2009 – Present (current PCE max ~1,000 µg/L)

- Several Other Groundwater Plumes
  - o Upgradient TCE (max ~8,000 µg /L)
  - o Upgradient petroleum hydrocarbons including ~3 feet of LNAPL, Benzene (max ~4,000 µg/L) and MTBE (max ~6,000 µg/L)



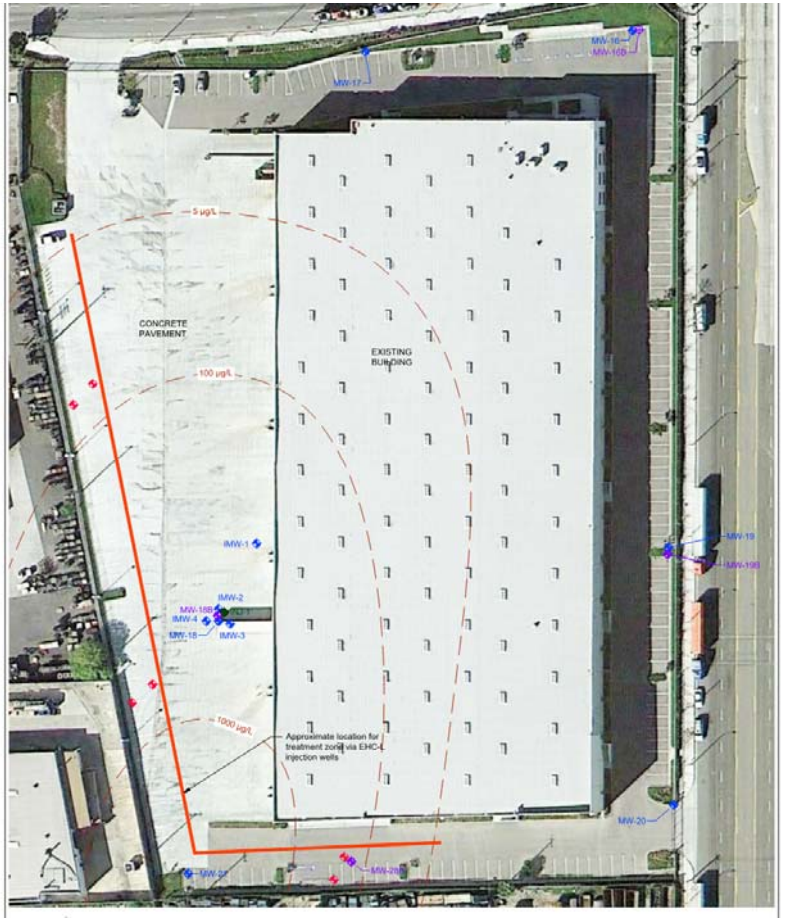
Preliminary GW RAP and Feasibility Study

Treatment Barrier Alternatives

- EHC, EHC-L, Ozone, P&T

Feasibility Study

- Advantages and Disadvantages
  - o Site Impact (e.g. days on site)?
  - o Current Aquifer Conditions (ORP/DO/DHC/GW Depth and Velocity)?
  - o Well-known/Proven Technology?
  - o Radius of Influence?
  - o Reinjection Rate?
  - o Cost?

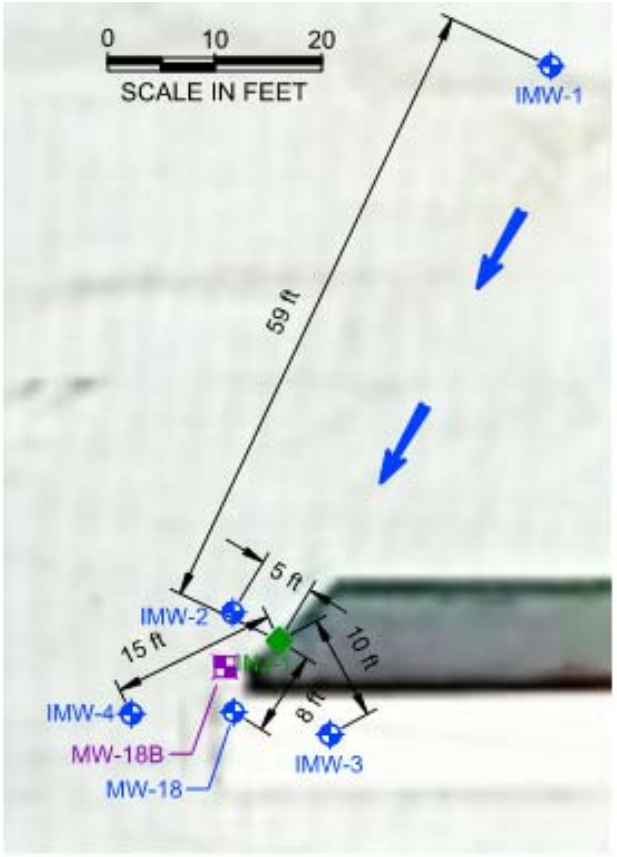


Pilot Test Selection (What is EHC-L®?)

- First introduced to the market in 2011.
- Two components mixed in the field:
  - Emulsified Lecithin Substrate (ELS™) 25% Microemulsion → Organic Carbon
  - Ferrous Iron (Fe 2+) → Soluble Iron
- Easily injected into wells as opposed to the original EHC® product introduced in 2005, which contains ZVI and would be more difficult to inject into wells.
- Published longevity of 2-3 years.

Pilot Test Objectives

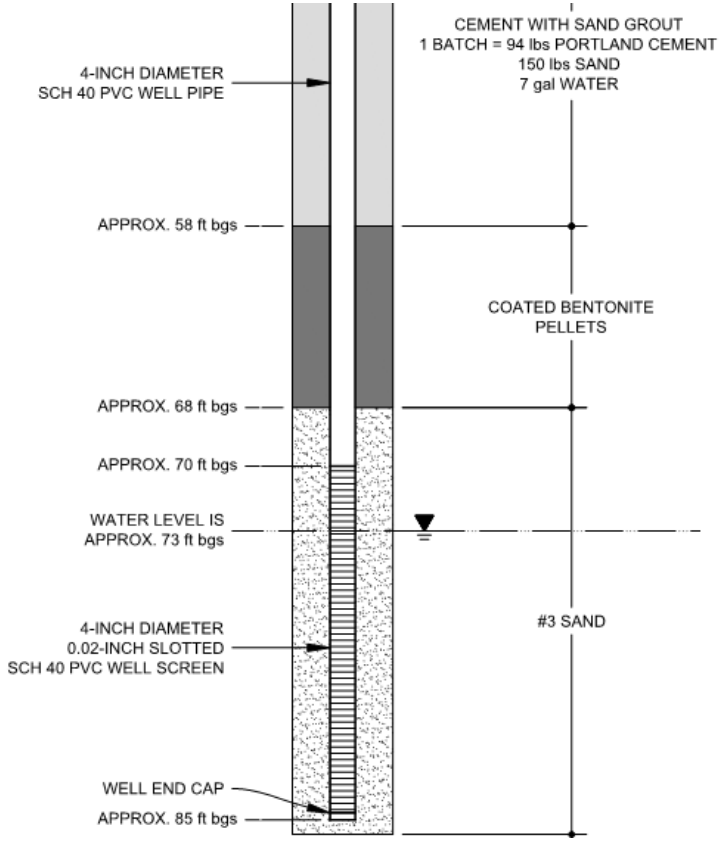
- EHC-L ability to remediate PCE and TCE
- VOC degradation rates
- Microbial population sustainability
- Injection Parameters
- ROI
- Duration of EHC-L effectiveness



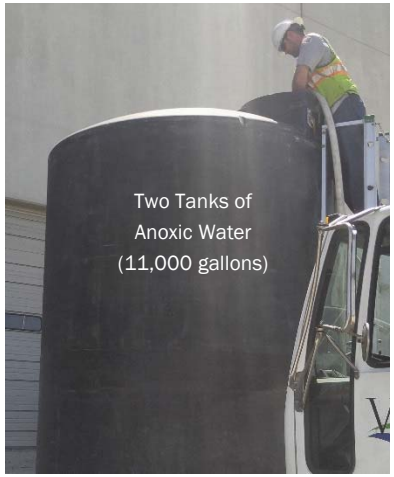
Pilot Test Well Installations

- Sonic Rig used vs. traditional HSA

- Optimized the well sealing design (based on a University of Nebraska-Lincoln grout study between 2001 and 2006).



Pilot Test Injection Amendments



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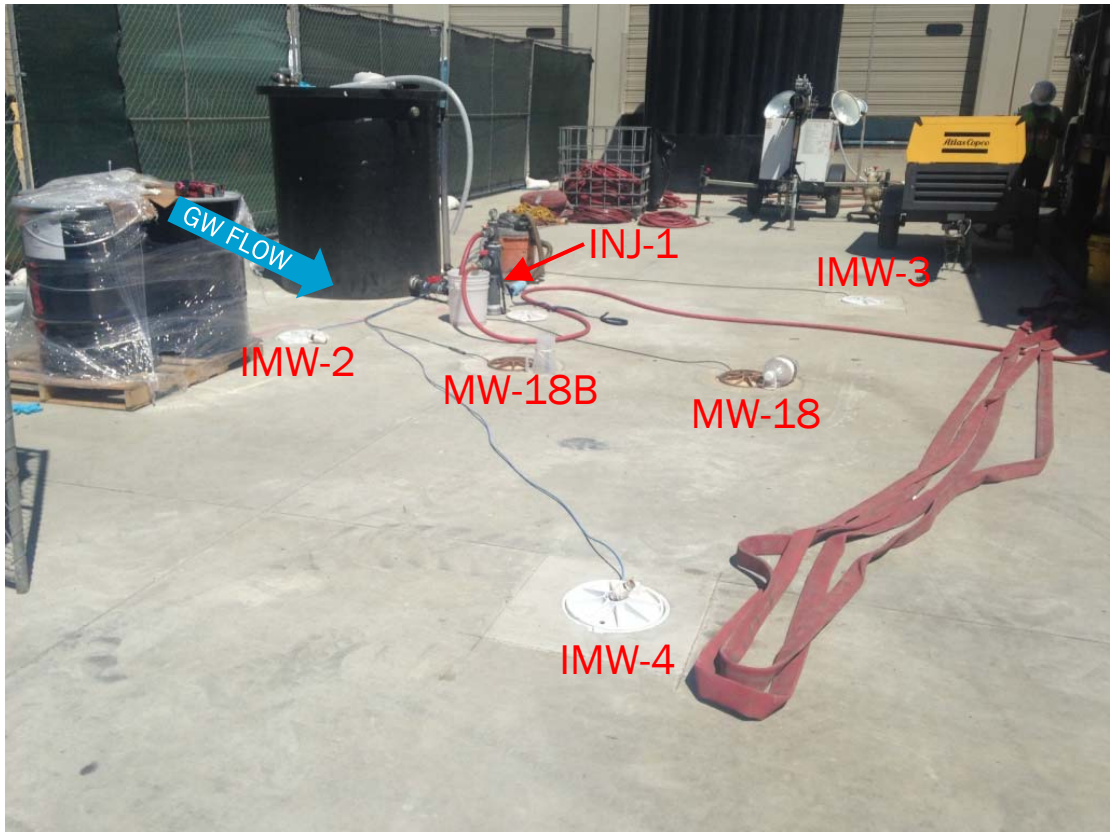
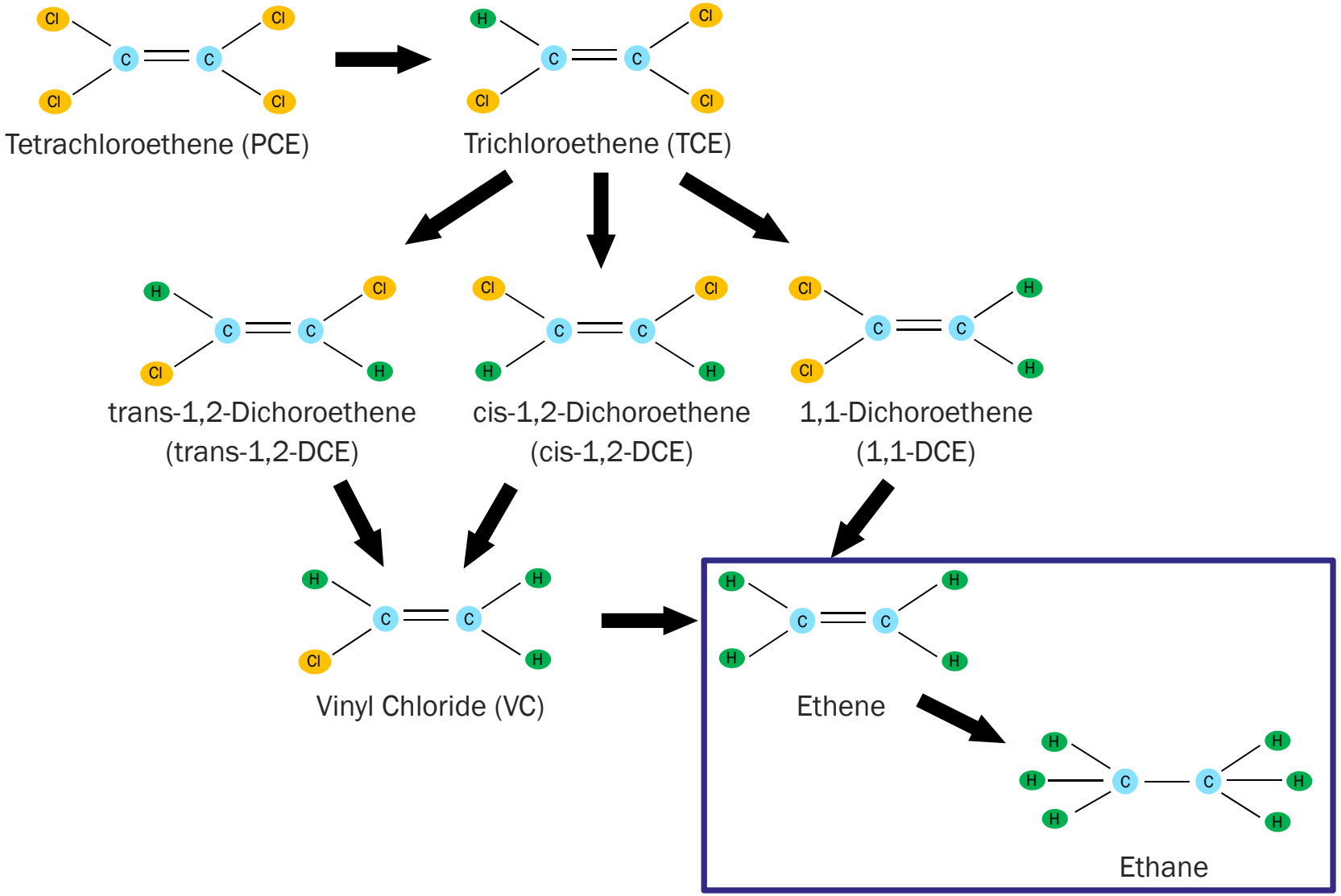
Pilot Test Injection



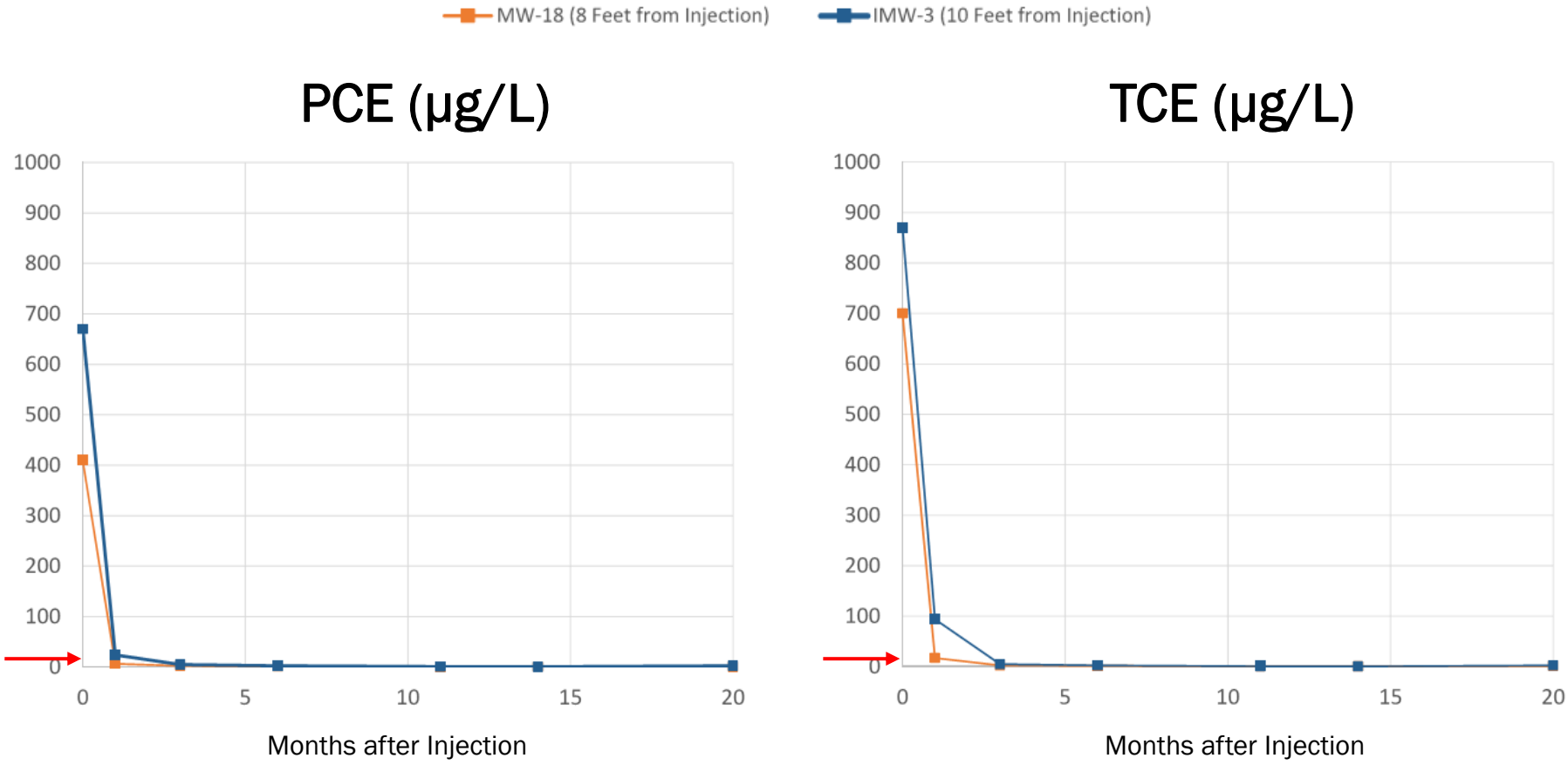
Data Loggers for Injection Monitoring

Tracer Dye Field Test at IMW-3

Reductive Dechlorination Pathway of PCE/TCE



Results at MW-18 and IMW-3 (8 and 10 feet from INJ-1: Within ROI)



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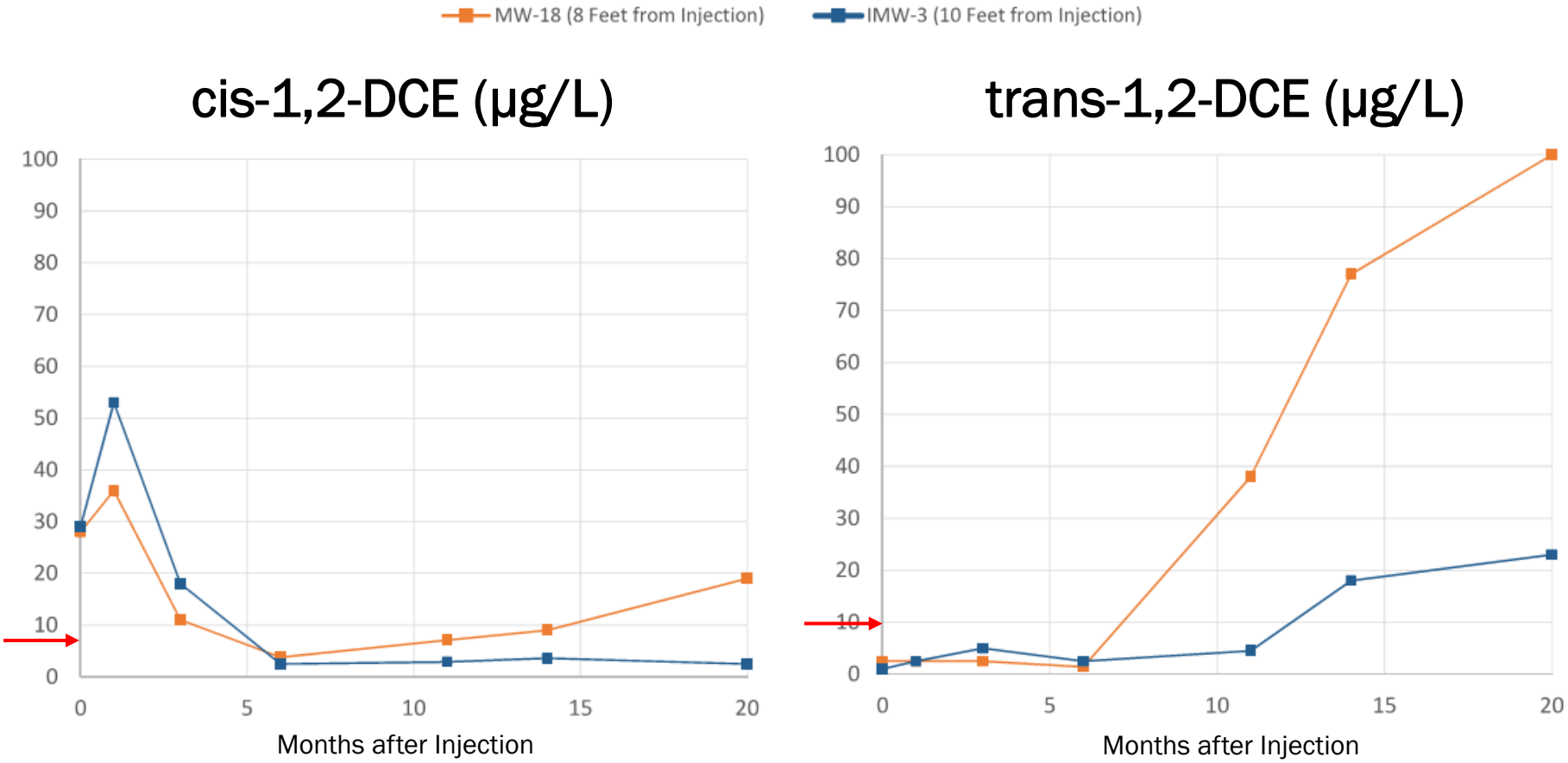

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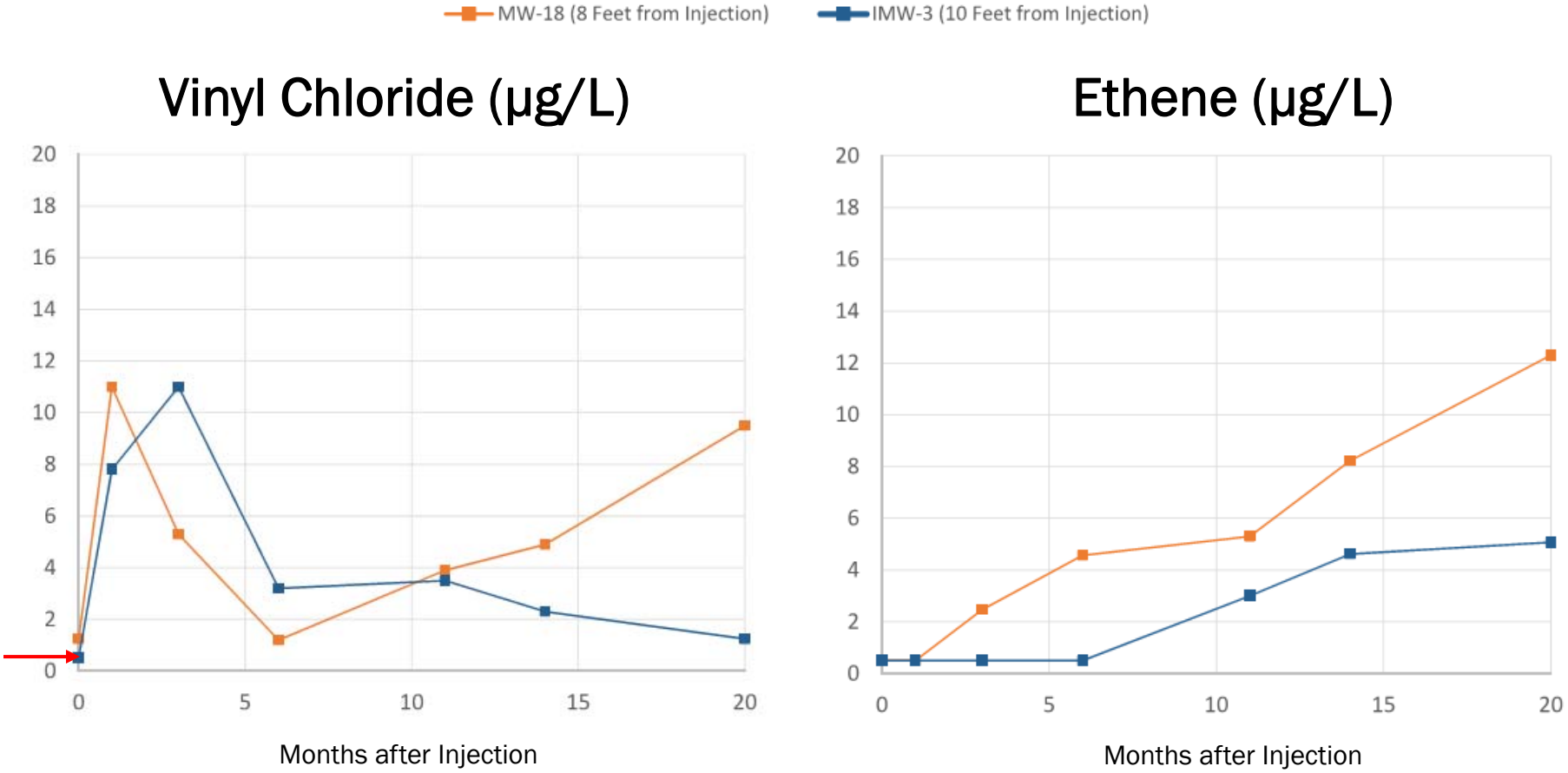
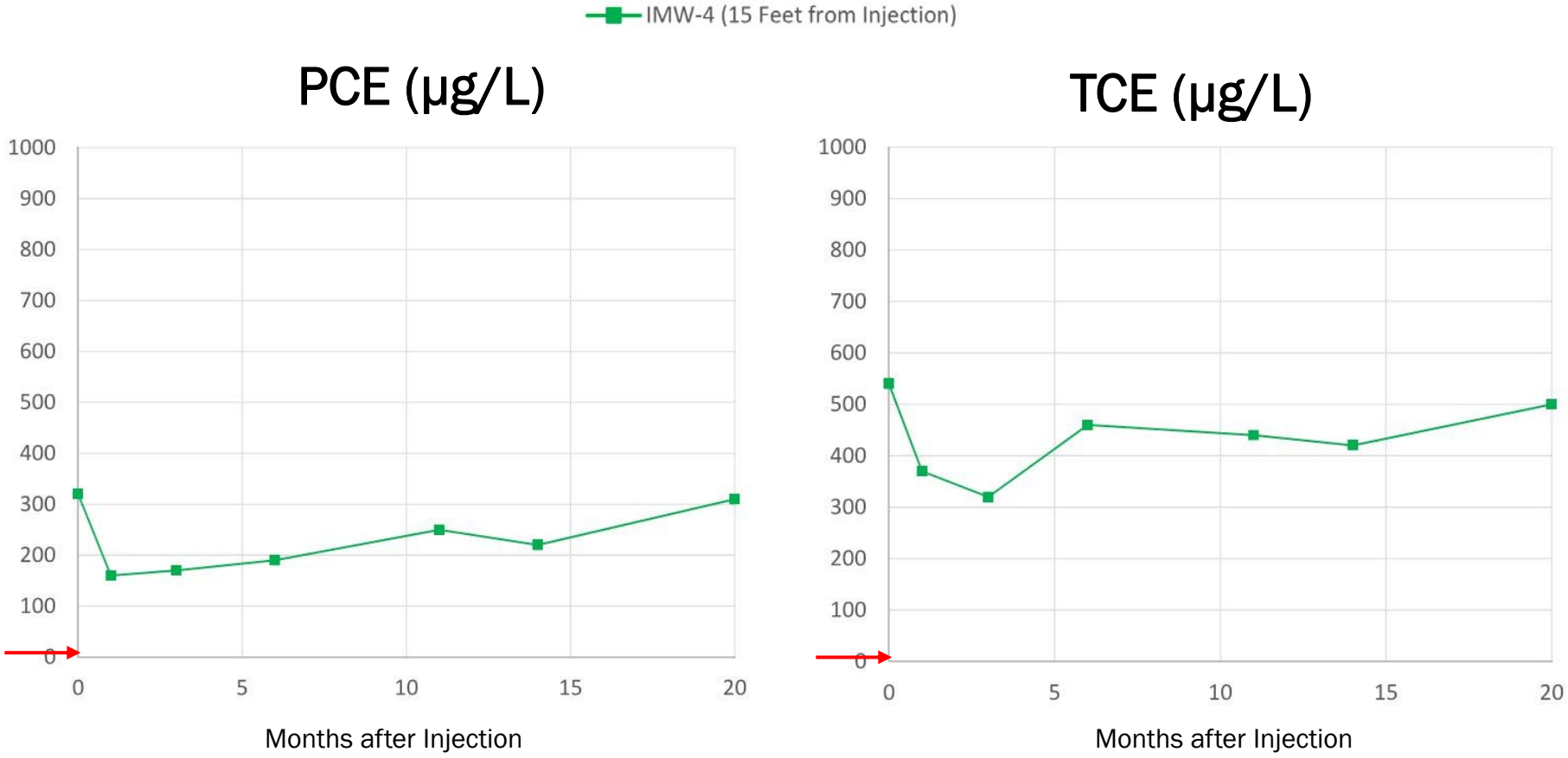


Results at IMW-4
(15 feet from INJ-1: Outside ROI)



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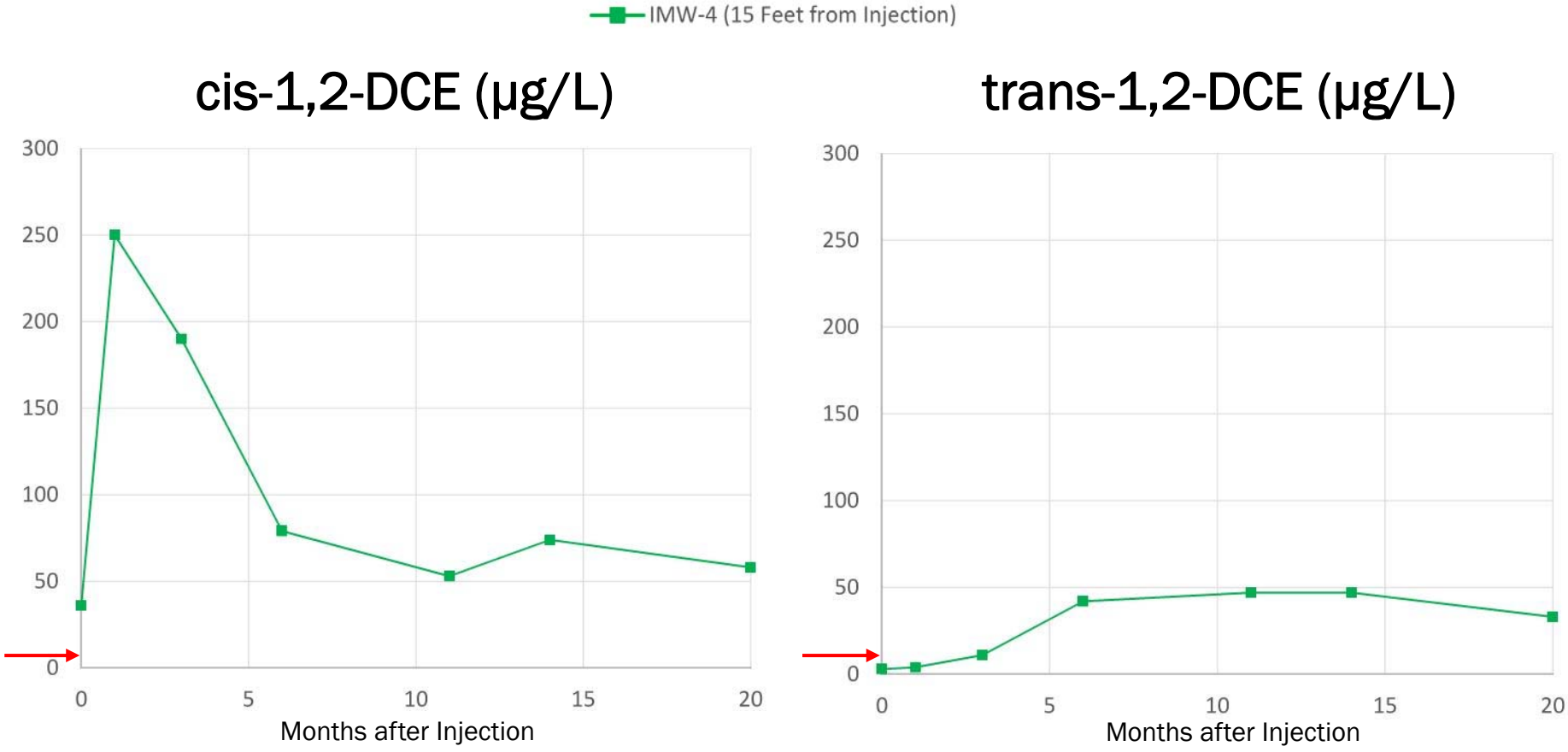

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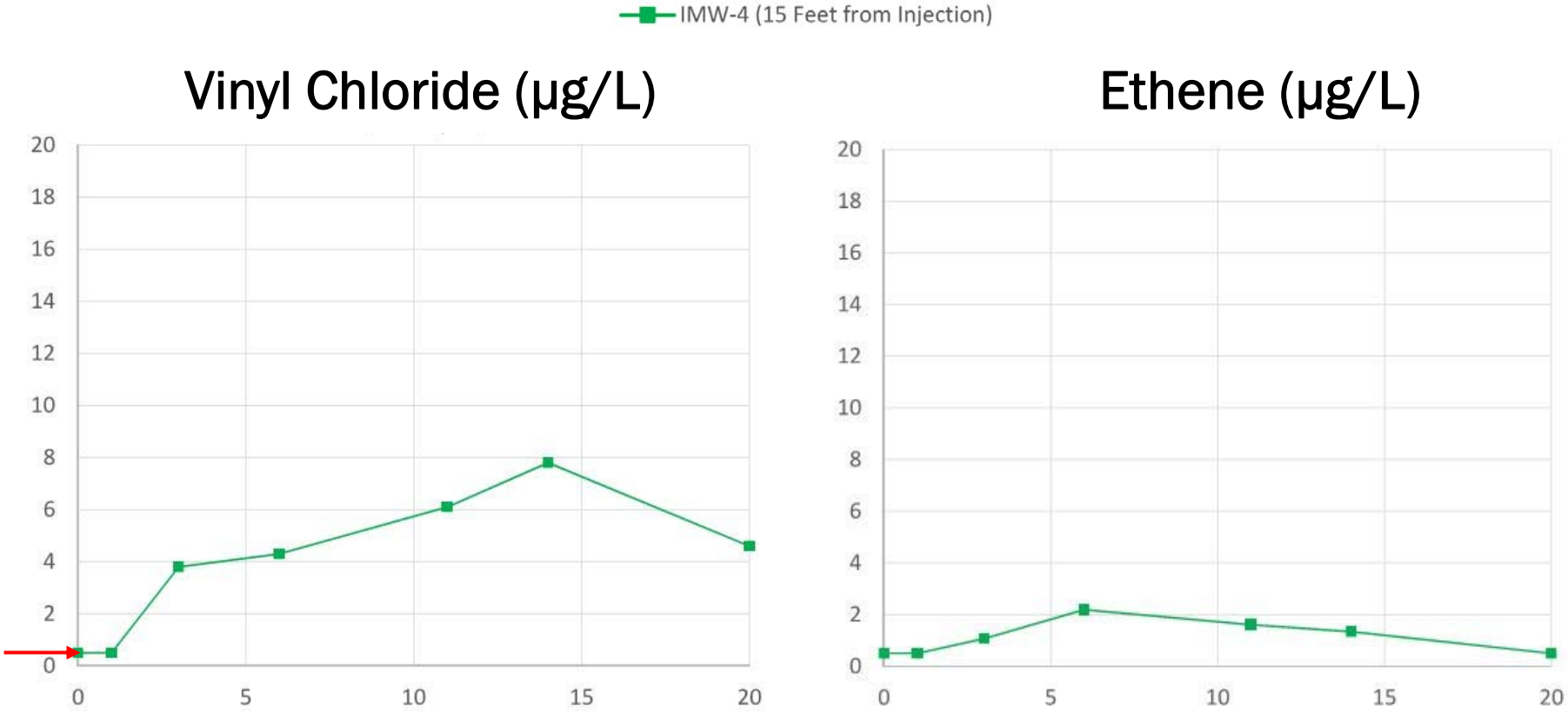
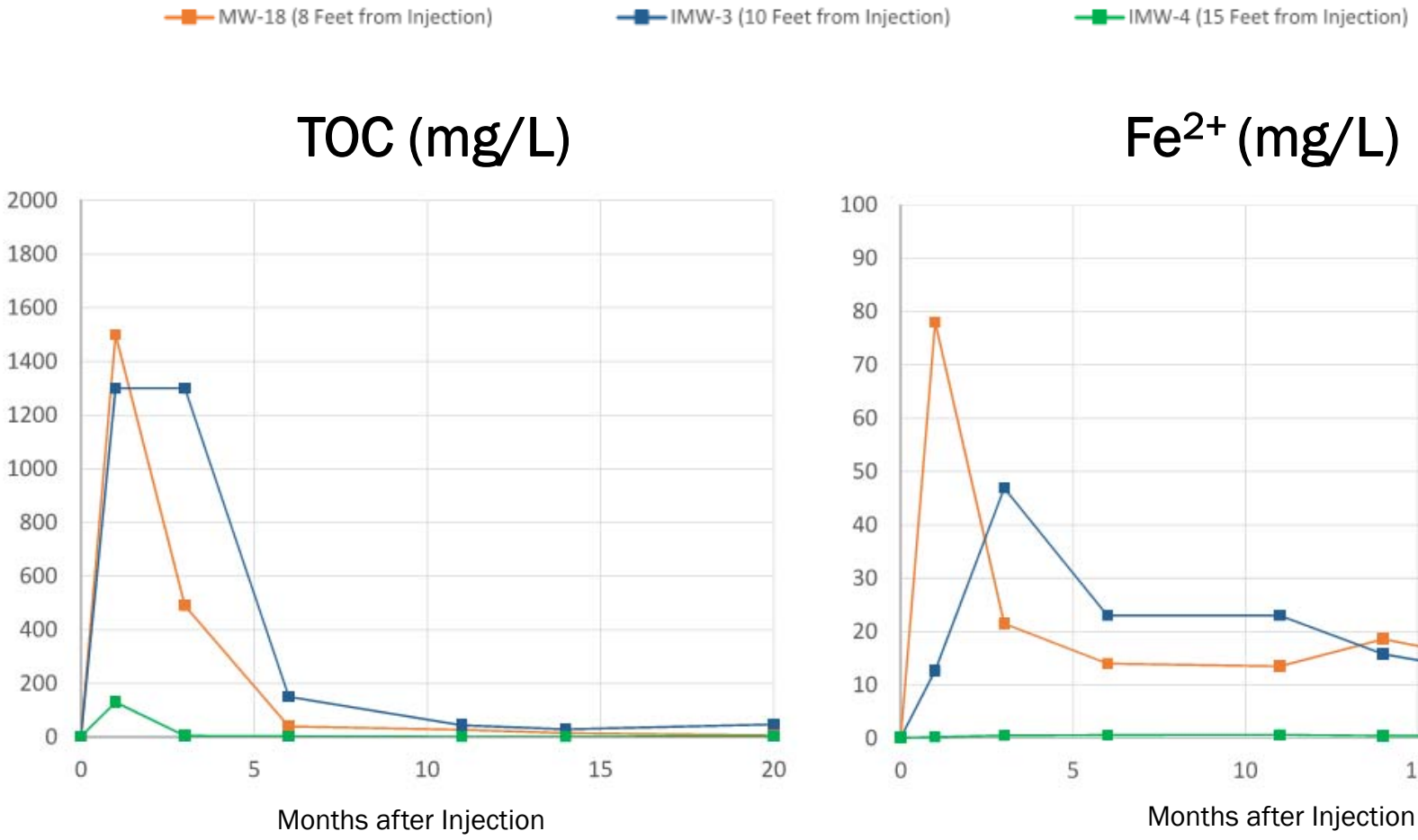
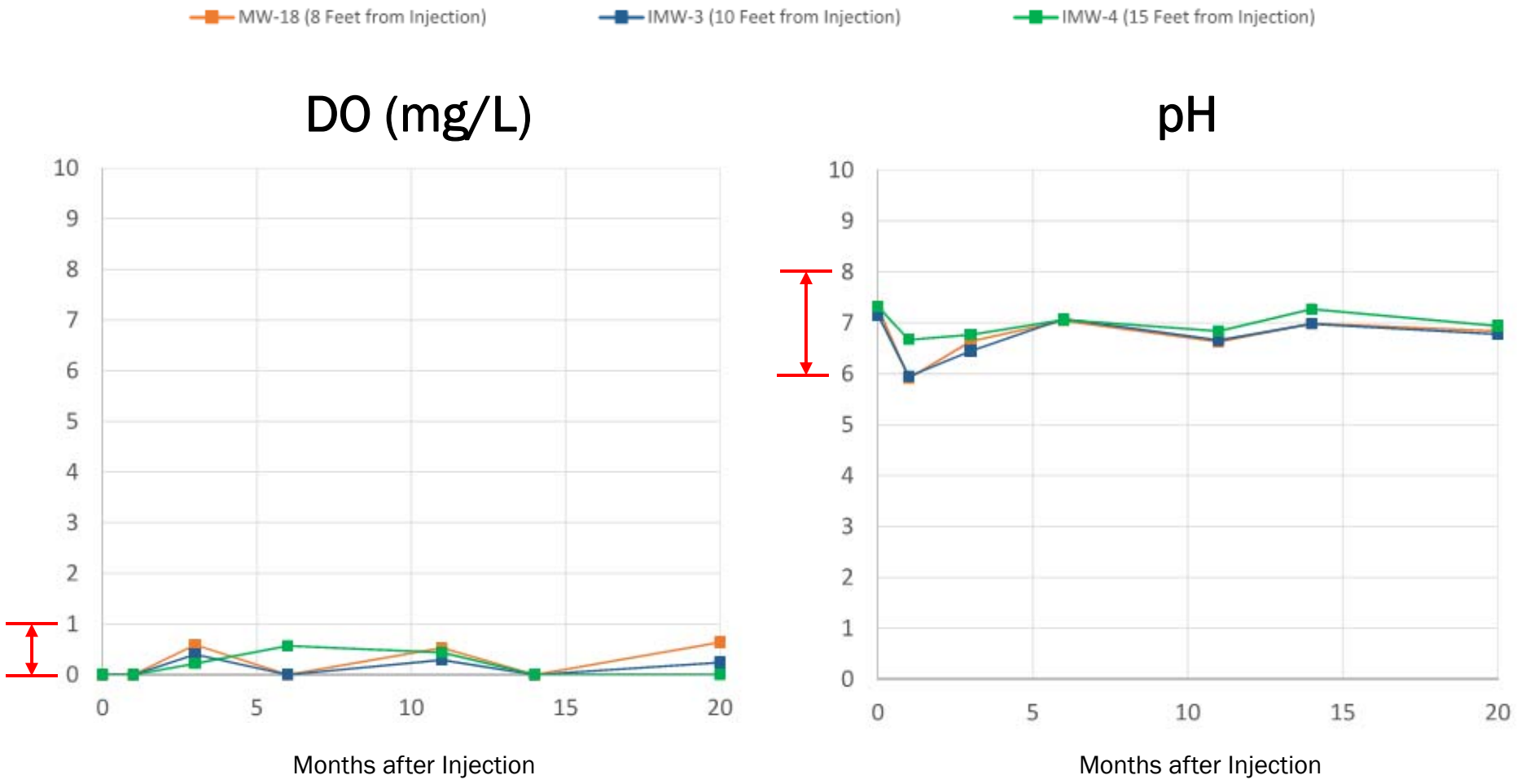


Results (EHC-L Presence)



Results (Water Quality Parameters)



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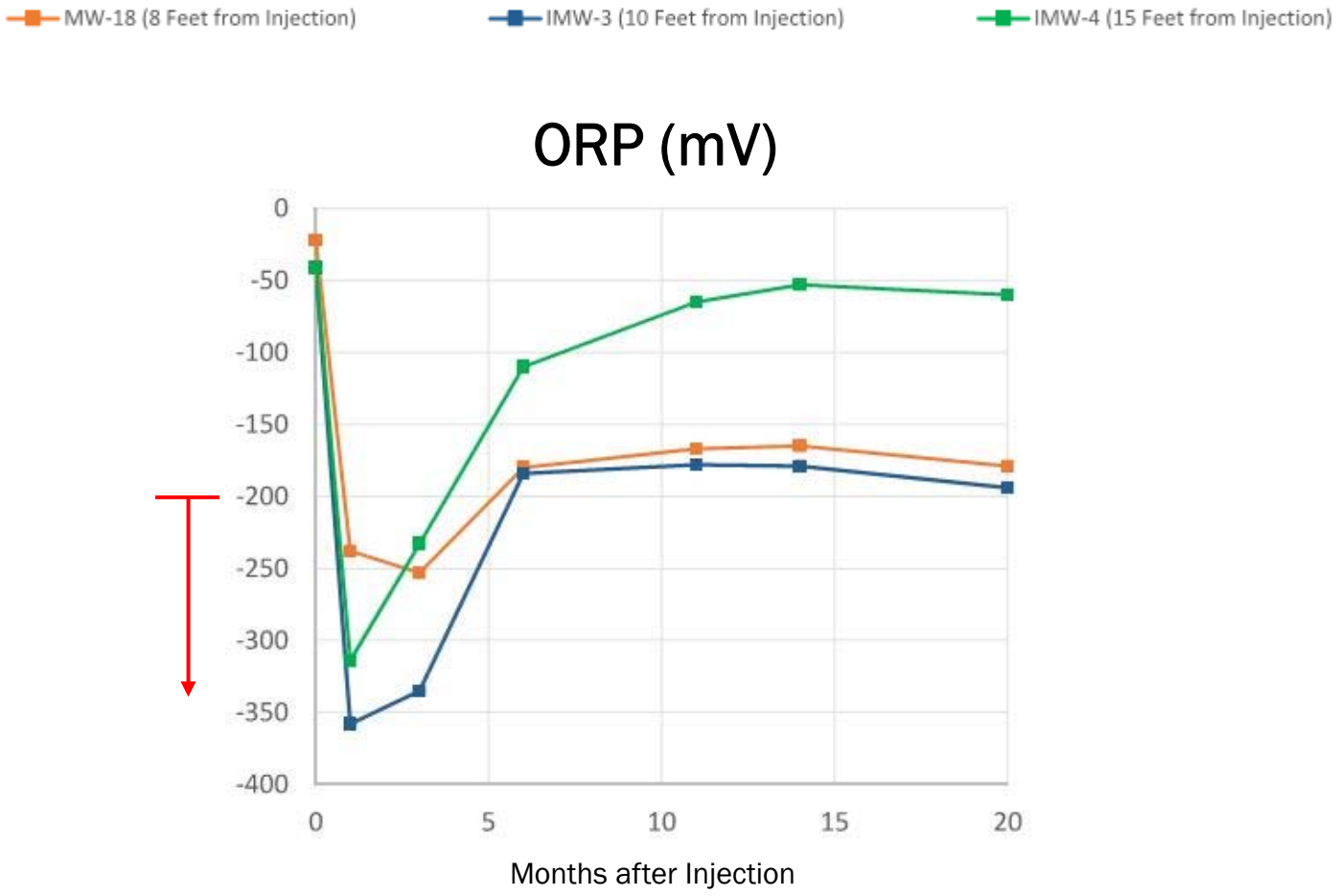
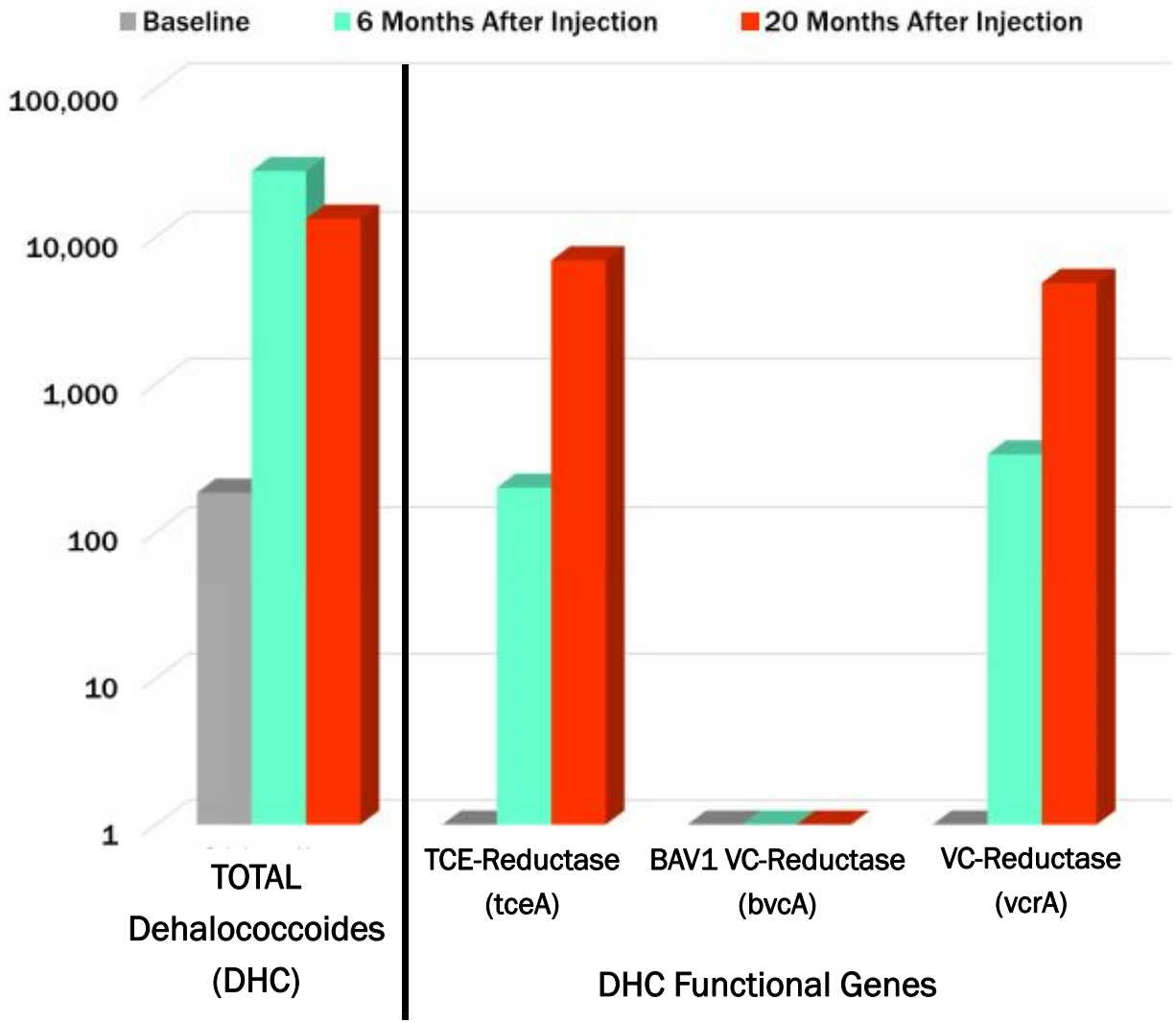
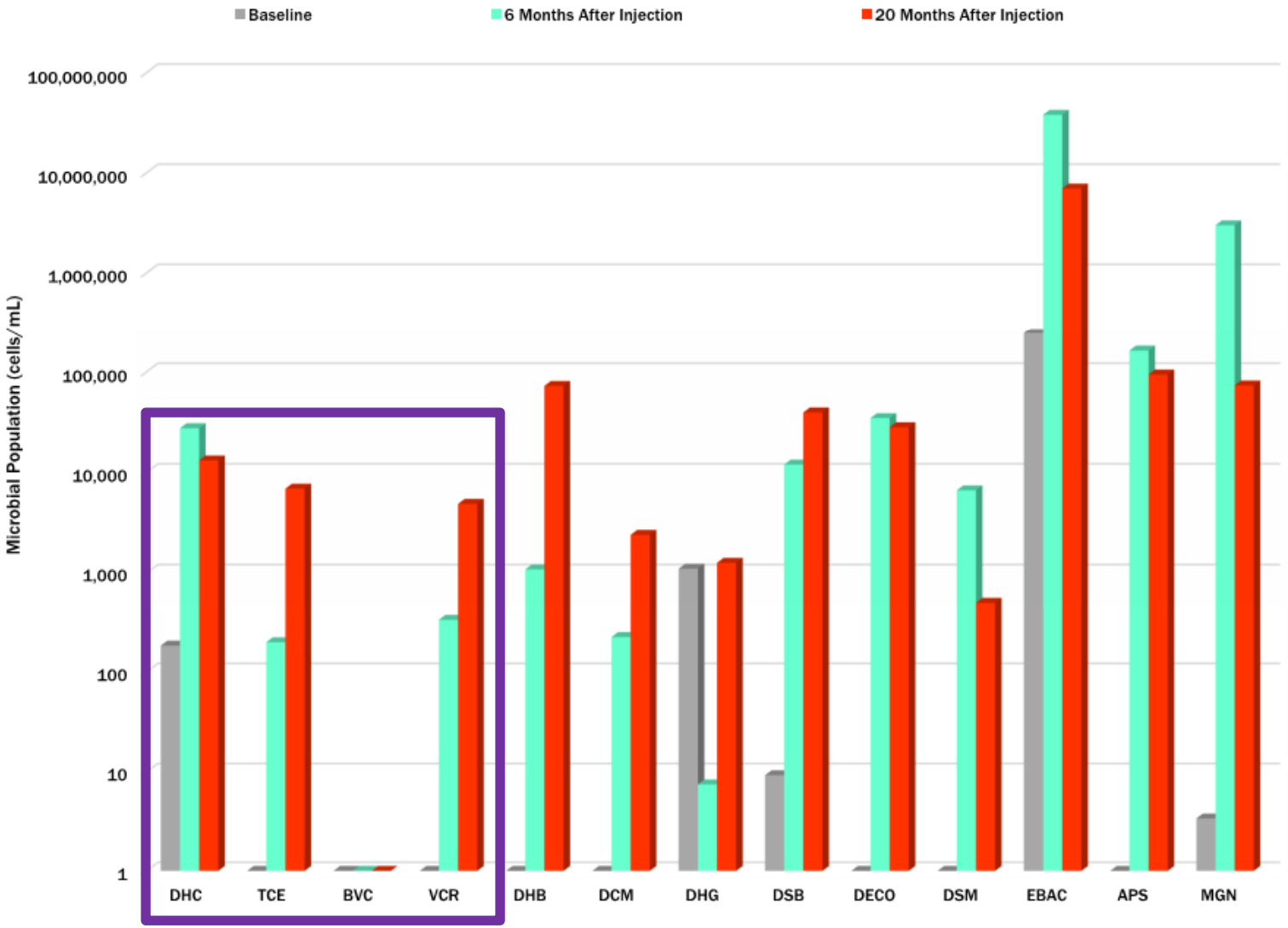


Results – DHC Populations (cells/mL)



Results – Other Microbial Populations (cells/mL)



Pilot Test Conclusions

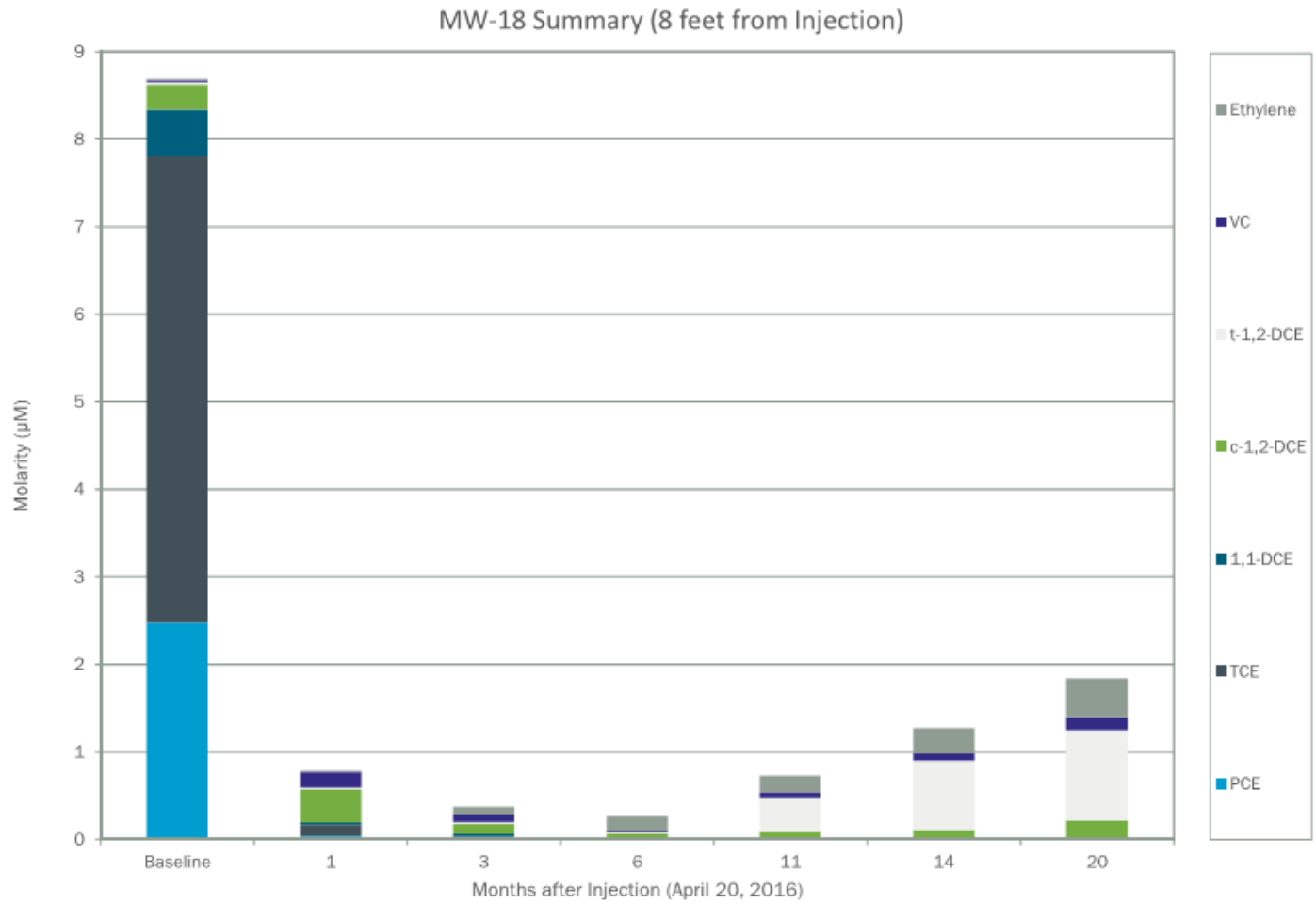
REVISIT PILOT TEST OBJECTIVES:

- EHC-L ability to remediate PCE/TCE:
  - ✓PCE and TCE were quickly reduced below MCL at all locations within 10 feet of the injection well.

- VOC degradation rates (see next slides)

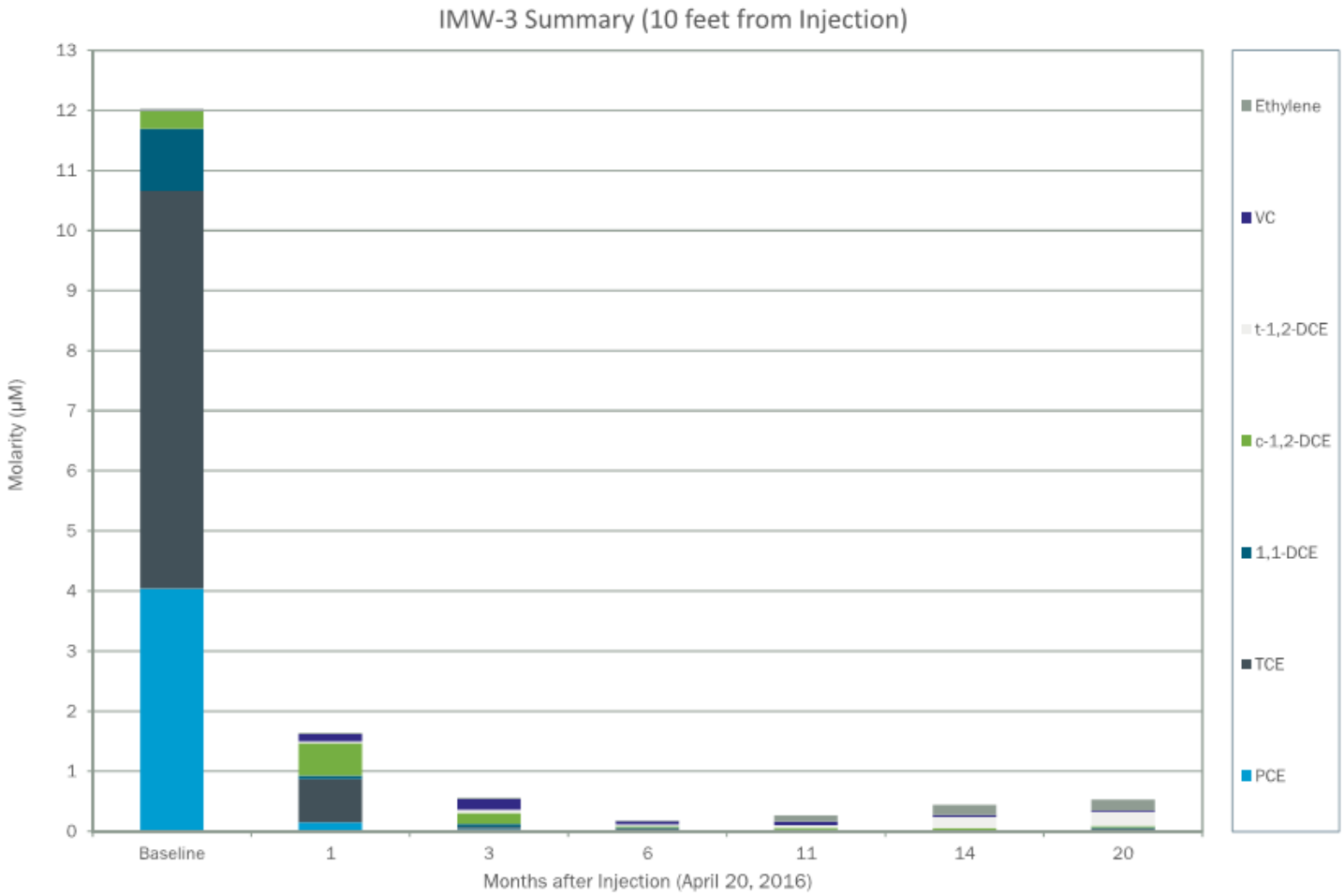
Pilot Test Conclusions

- VOC degradation rates:



Pilot Test Conclusions

- VOC degradation rates:



Pilot Test Conclusions

REVISIT PILOT TEST OBJECTIVES:

- Microbial Populations:
  - ✓All microbial populations remain elevated relative to pre-injection levels.

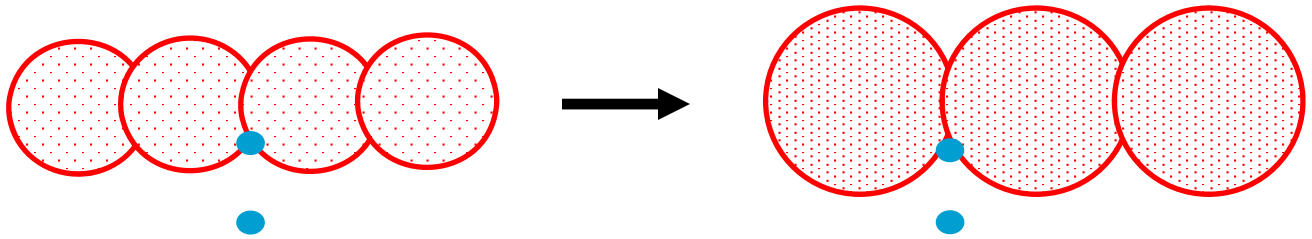
- Injection Parameters:
  - ✓15 gpm with no back pressure.
  - ✓No daylighting.

- ROI:
  - ✓At least 10 feet laterally from injection well --- Estimated at 12.5 feet based on all information.

- Duration of EHC-L effectiveness:
  - ✓Favorable reducing conditions persist 20 months after injection (e.g. no PCE rebound, low ORP, and stable, near-neutral pH).

Full Scale Design Considerations

- Spacing increased from the original assumption of 20 feet to 25 feet.
- Possible change in microbial culture and/or increase in DHC during full-scale injection.
- Although PCE/TCE remain low ~2 years after injection, reinjection of EHC-L is still recommended at 2 years to increase microbial activity to address trans-/cis-DCE.



Acknowledgements

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Thank you.
Questions?

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