

Groundwater Recovery System Replacement using Multiple Lines of Evidence MNA Demonstration

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OVERVIEW



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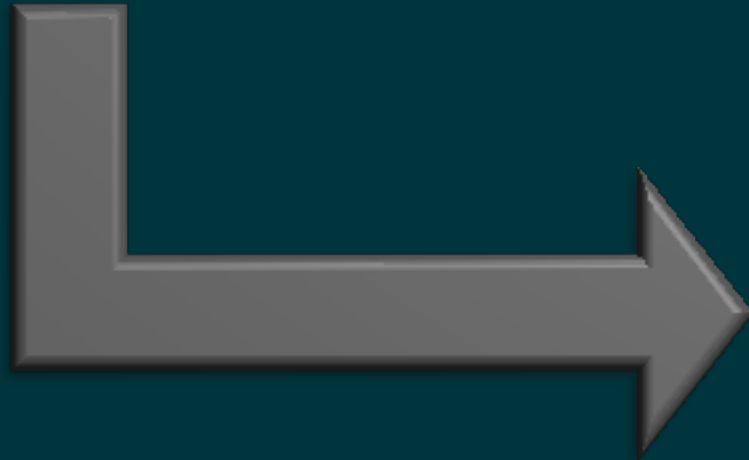
01

ACKNOWLEDGMENTS

- Colin Wasteney / Tracey Vannest – AECOM
- Betsy Witt – Client Stakeholder
- AECOM Field Sampling Personnel
- Microbial Insights – Microbiological Support

01

**EVOLUTION
AND
ADVANCEMENTS**



ADVANCEMENTS

REGULATORY

- Shifts in
 - Perception
 - Acceptance
- Not a “Do Nothing” approach
- ↓
- Protocol Development
- ↓
- Increased approvals
- ↓
- Advanced Research

CONCEPTUALIZATION

- Robust Conceptual Site Models (CSMs)
 - High Resolution Characterization
 - Sequence Stratigraphy
 - Enhanced Sequence Stratigraphy
 - Downhole/Direct Monitoring Tools

IMPLEMENTATION

- Innovative in-situ amendments
- Right size/focused application
- Dual treatment approaches (i.e., ISCO and follow-on bio, etc.)
- Bench-scale and in-situ studies provide resources to study/document biological processes
- Novel consortiums for bioaugmentation

EVALUATION

- New microbiological tool (MBTs)
- Development of multiple lines of evidence (LOEs)
- “Nature finds a way”
- Acceptance of technology as being in the “toolbox”

DEMONSTRATION

- Advanced data visualization techniques
 - EVS
 - Surfer
 - Modeling
 - MBTs
- Plume Analytics
 - Area
 - Average Conc.
 - Mass
 - Center of Mass
- Statistics

02

BACKGROUND OBJECTIVES PROCESS



BACKGROUND

- GROUNDWATER RECOVERY SYSTEM (GWRS) OPERATED FROM LATE 1990S THRU 2022
- CHLORINATED ORGANICS PRIMARY COCs

OBJECTIVES

- INITIAL EVALUATION OF POTENTIAL ALTERNATIVE REMEDIAL APPROACH(2019)
 - GWRS STATUS
 - REVISED CSM (PRISM™)
 - PLUME ANALYTICS
 - NATURAL ATTENUATION PARAMETERS
 - INITIAL MICROBIOLOGICAL DATA

OUTCOME

- REGULATORY/STAKEHOLDER ENGAGEMENT LED TO TEMPORARY CESSATION OF GWRS TO DEMONSTRATE NATURAL ATTENUATION

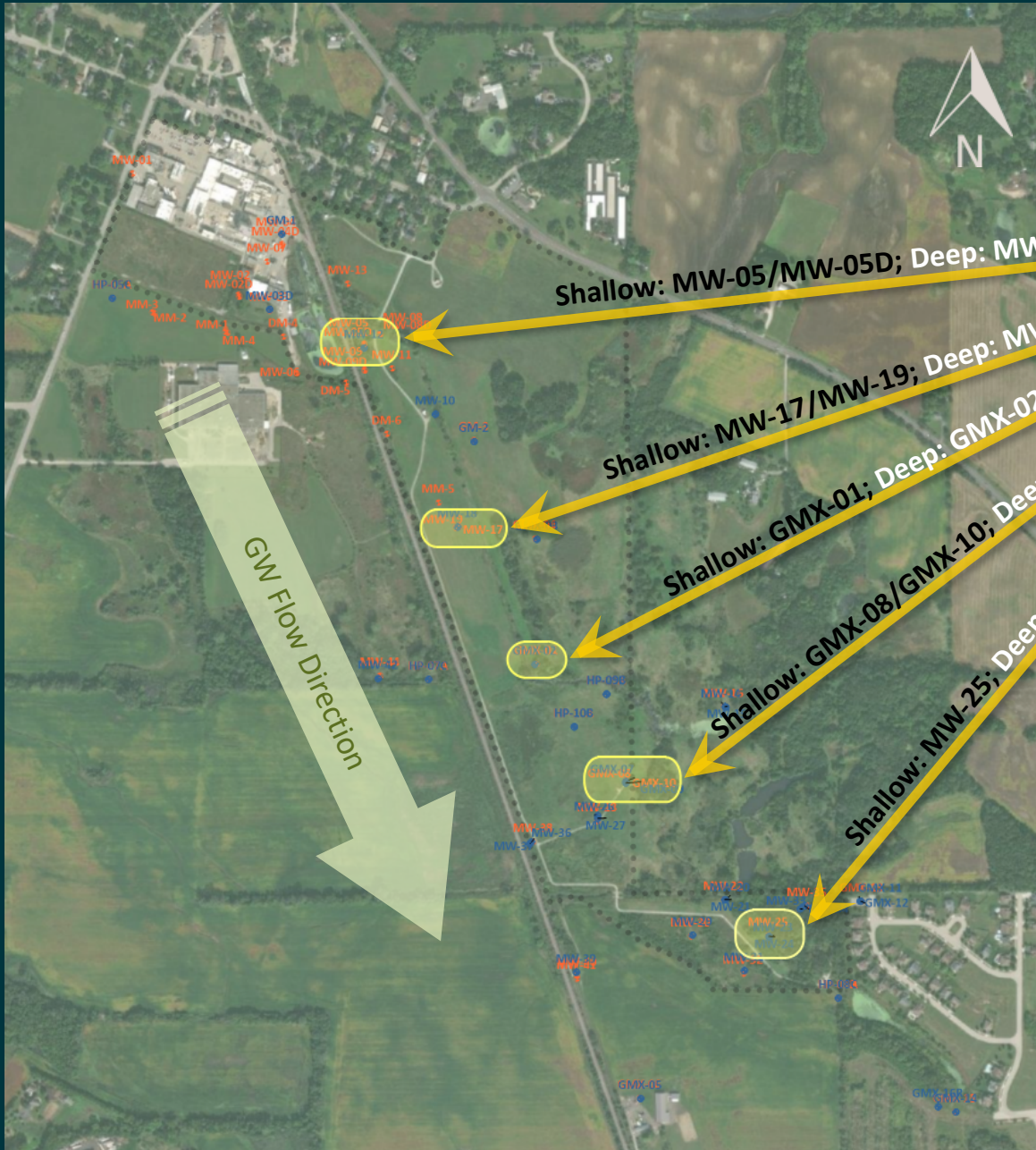
GW Monitoring Network

■ Shallow Zone

- MW-05
- MW-05D
- MW-17
- MW-19
- GMX-01
- GMX-08
- GMX-10
- MW-25

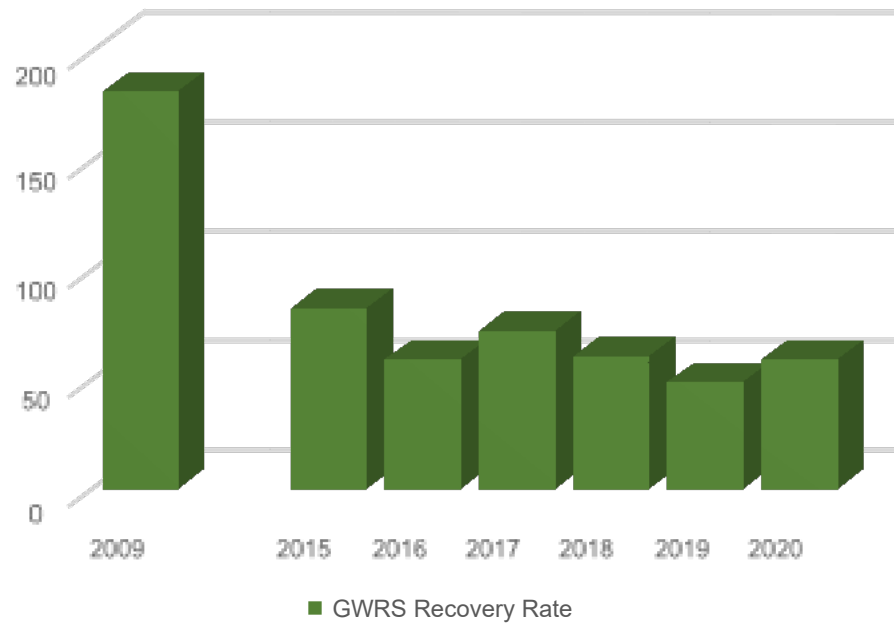
■ Deep Zone

- MW-12
- MW-18
- GMX-02
- GMX-07
- GMX-09
- MW-23
- MW-24



03

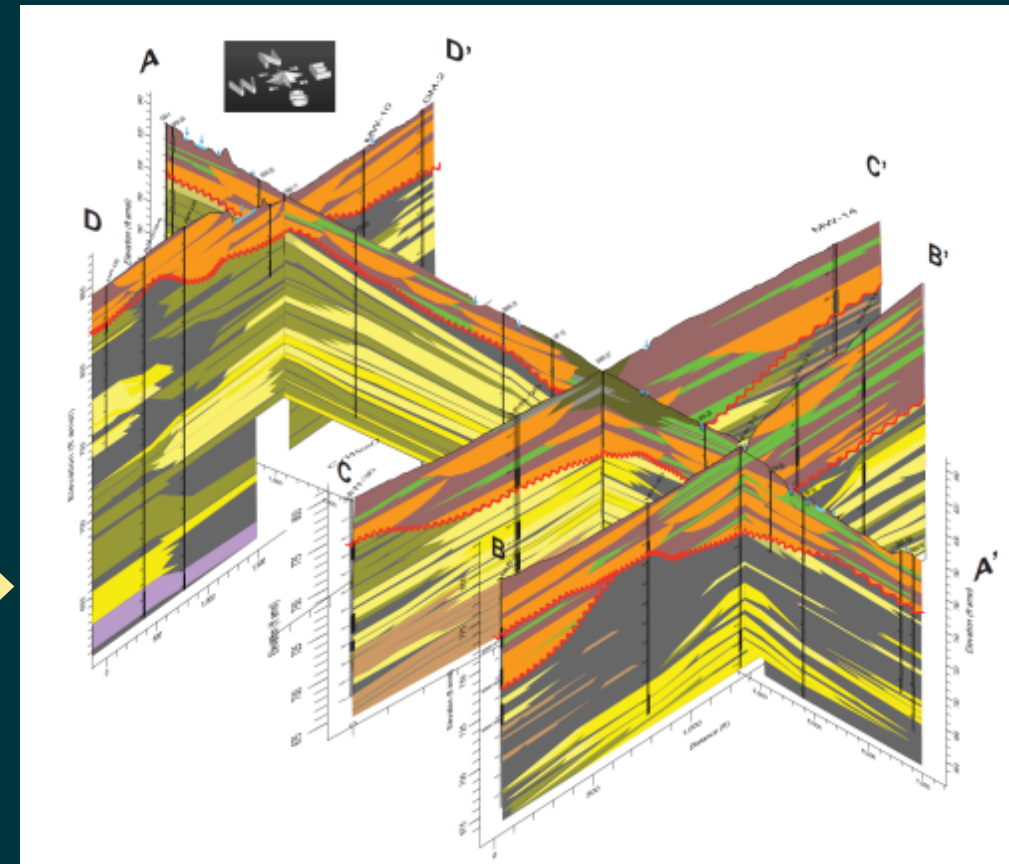
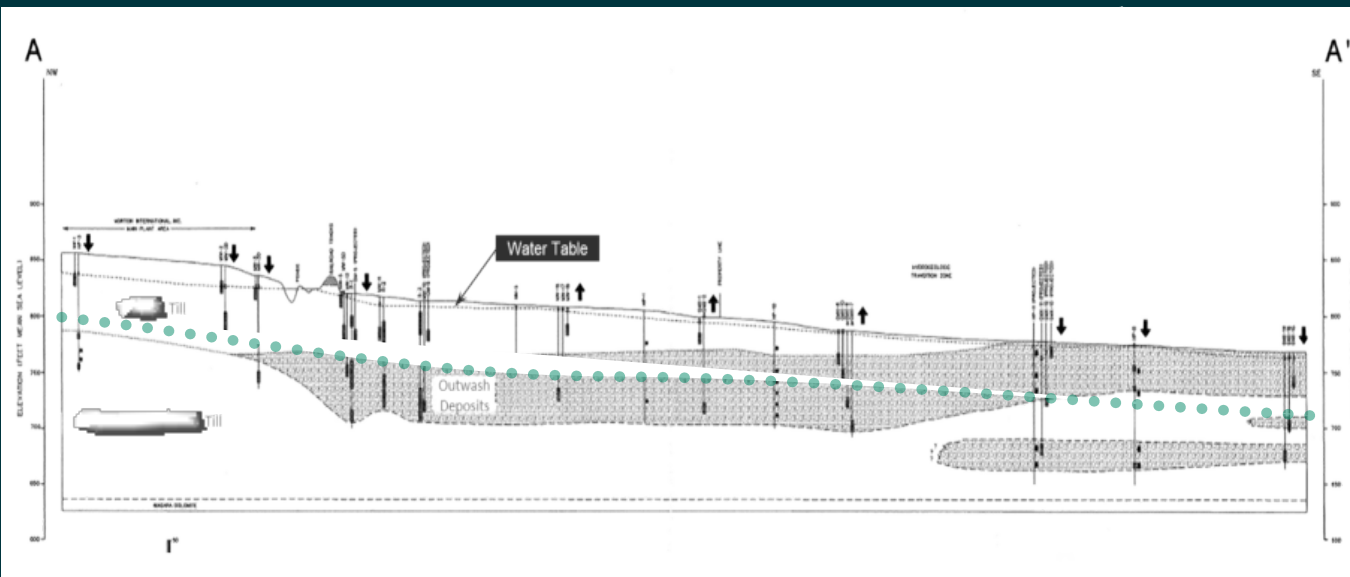
INITIAL LINES OF EVIDENCE (LOEs) REVIEW

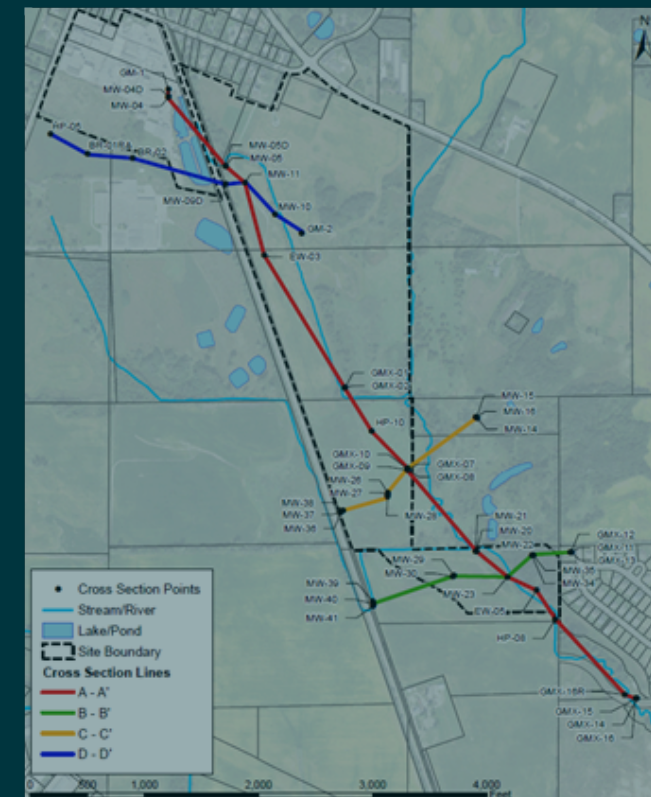
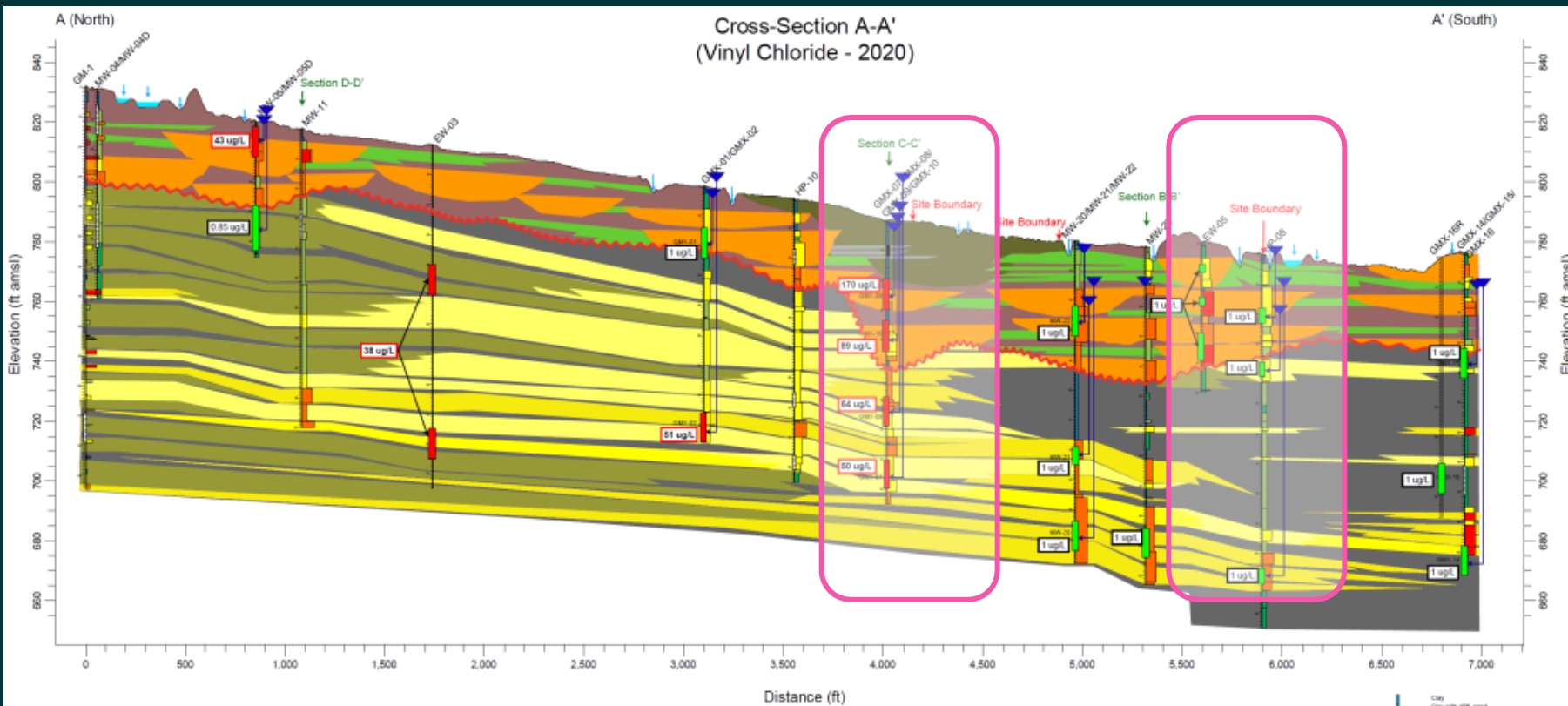


Decrease in GW recovery rates support re-evaluation of remedial approach

The results of the PRISM evaluation identified:

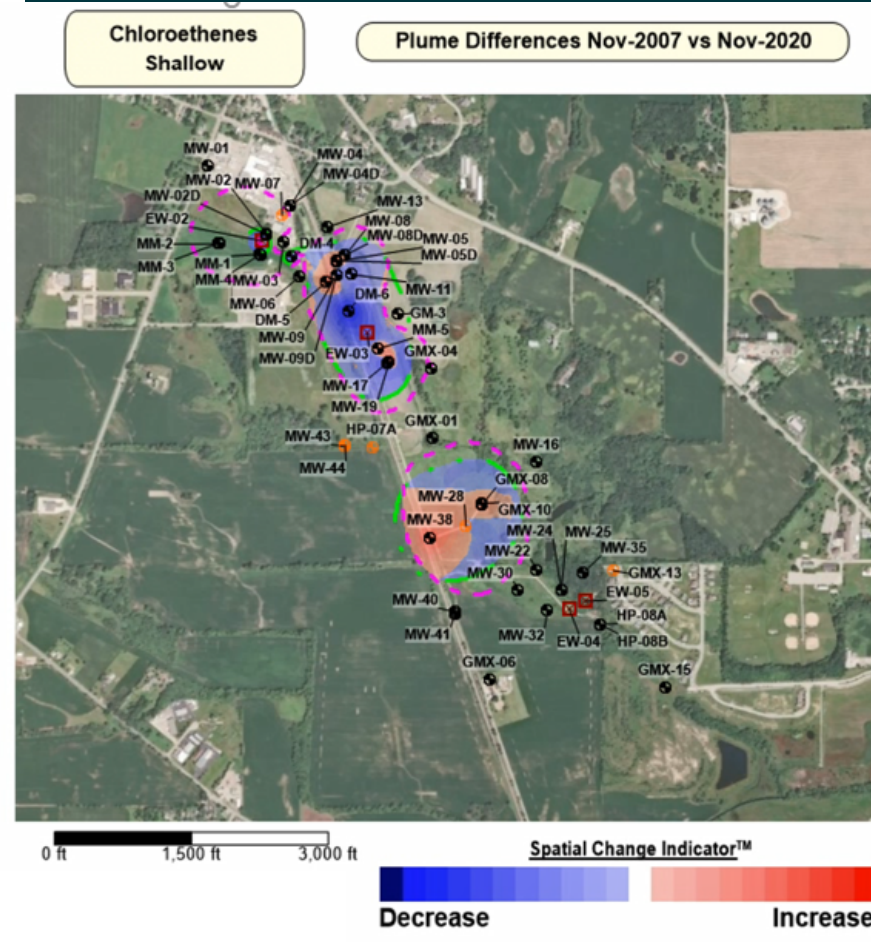
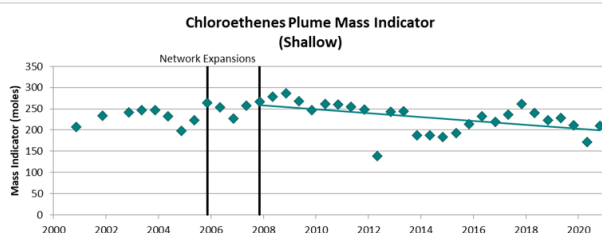
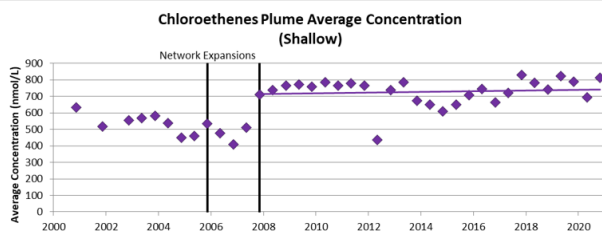
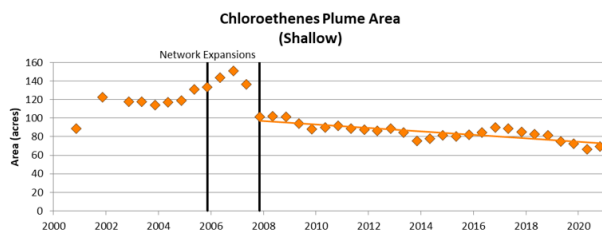
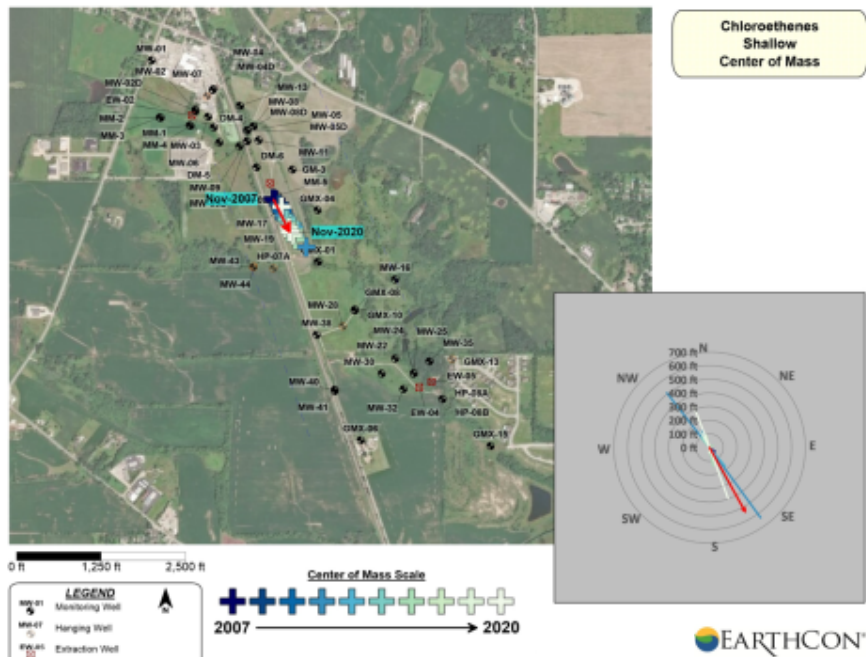
- Increased complexity of subsurface depositional environment
- Significant low permeability area to the south of the Site





PRISM™ provides insight to geologic influence on COC concentrations:

- Concentrations increase (deep → shallow)
- Consistent with upward gw flow direction
- Lack of COC's to the south due to low permeability area



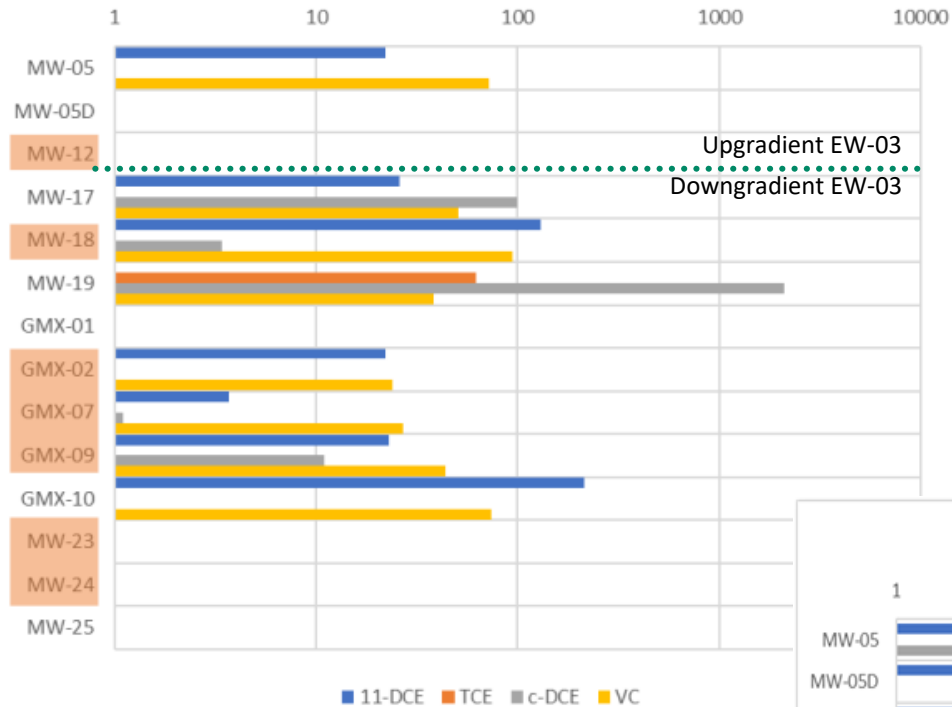
Plume Analytics provides valuable insight to the site specific:

- Plume Area
 - Decreasing trend
- Plume Conc.
 - No trend
- Plume Mass
 - Decreasing trend

Shallow Zone illustrated but similar results in Deep Zone

LOEs support ongoing attenuation processes

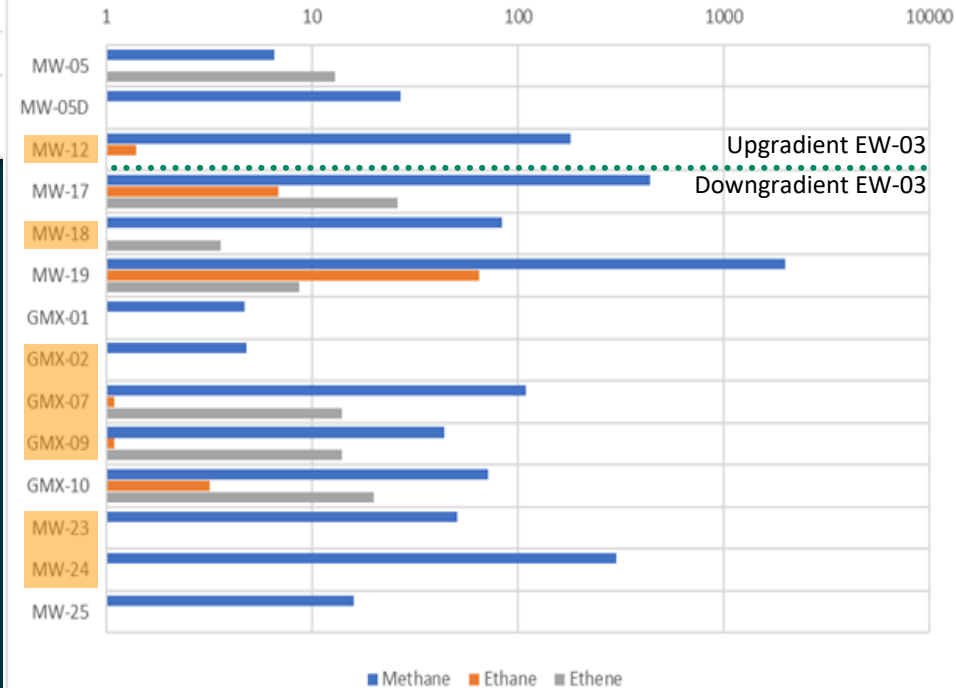
Chlorinated VOCs (ug/L)



Chlorinated VOCs

- Limited VOCs detections upgradient of main GWRS
- Limited parent product – TCE
- Accumulations of degradation products downgradient
- Extent limited to area proximal to GMX-10

Dissolved Gas (µg/L)



Dissolved Gases

- Methane detected throughout centerline MWs
- Ethene (degradation end product) detections extend to VOC limits
- Ethene concentrations generally highest downgradient of recovery wells

04

ENHANCED LOEs REVIEW

NA Demonstration has been implemented following shutdown of the Groundwater Recovery System in April 2022

- Cessation of pumping from Groundwater Recovery System (GWRS) in April 2022

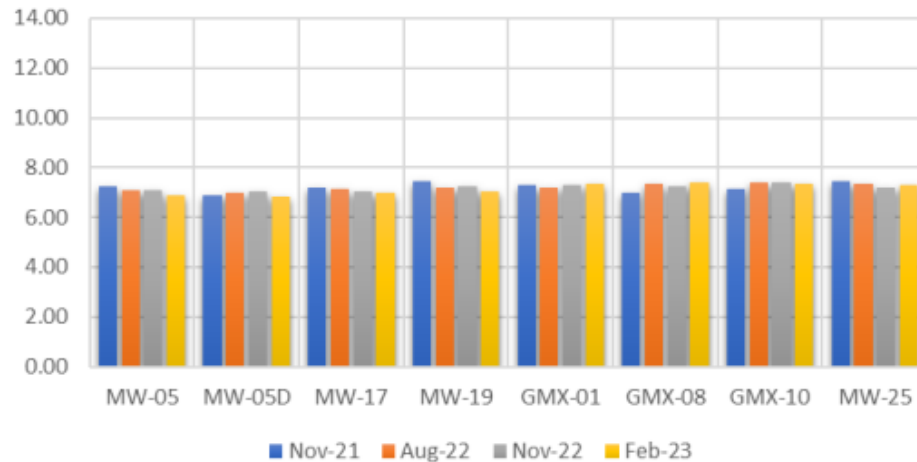
- Scope of Work
 - Quarterly GW Monitoring
 - *1st event - August 2022*
 - *2nd event – November 2022*
 - *3rd event - Feb 2023*
 - Sampling completed for VOCs, inorganic, and microbiological parameters
 - Plume Analytics Update (end of demonstration period)
 - Status Updates
 - Final Report

NA DEMONSTRATION OBJECTIVES

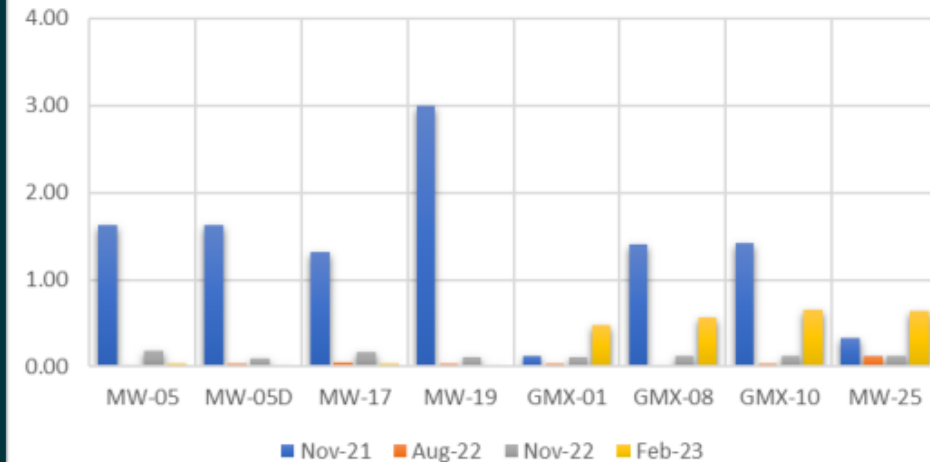
- EVALUATE GW CONDITIONS/PLUME STABILITY THROUGH ENHANCED GW MONITORING PROGRAM

- EVALUATE DATA AND PRESENT THE FINDINGS

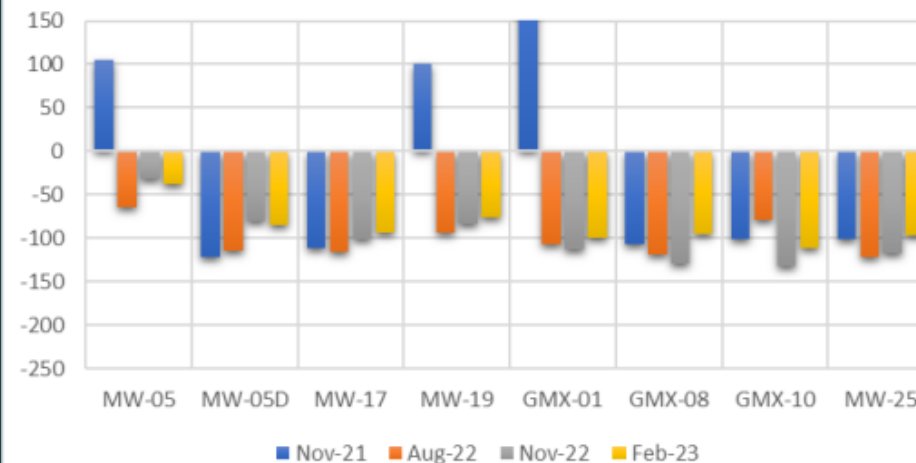
pH - Shallow



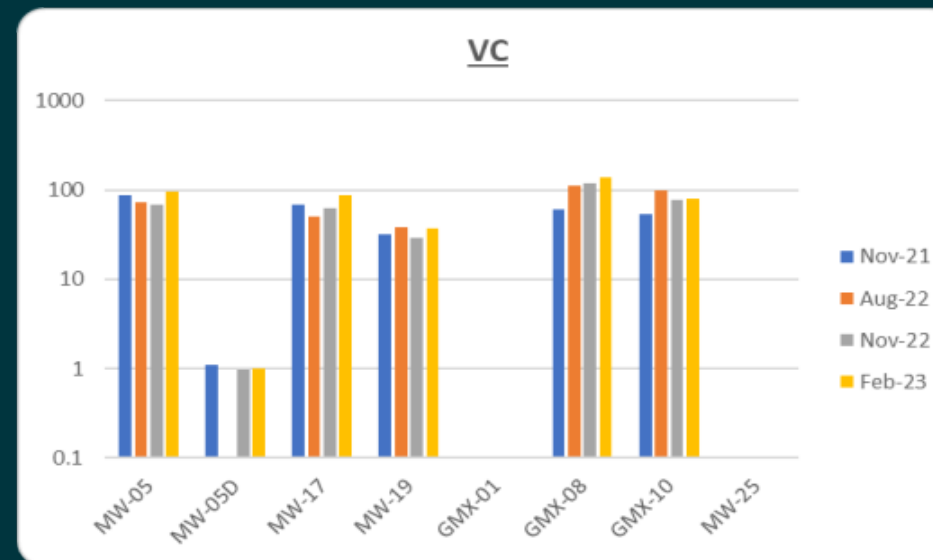
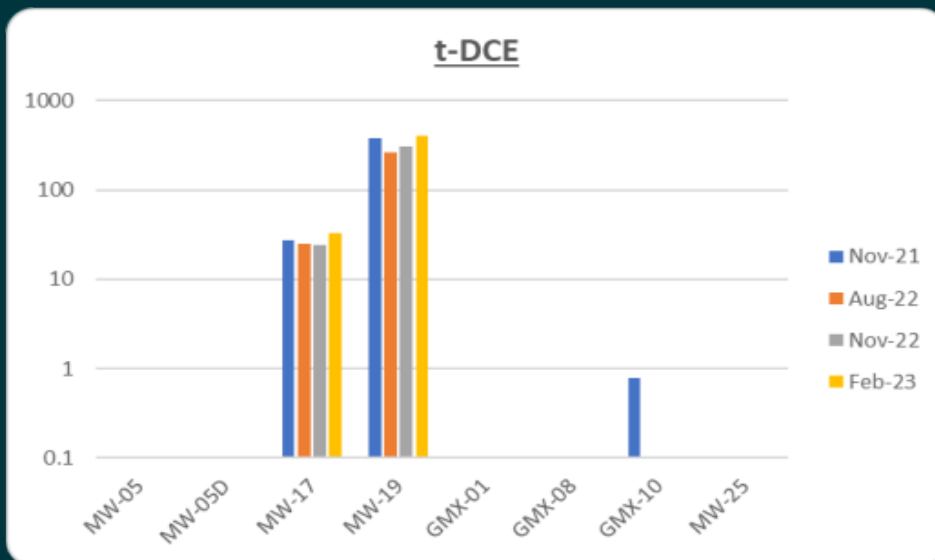
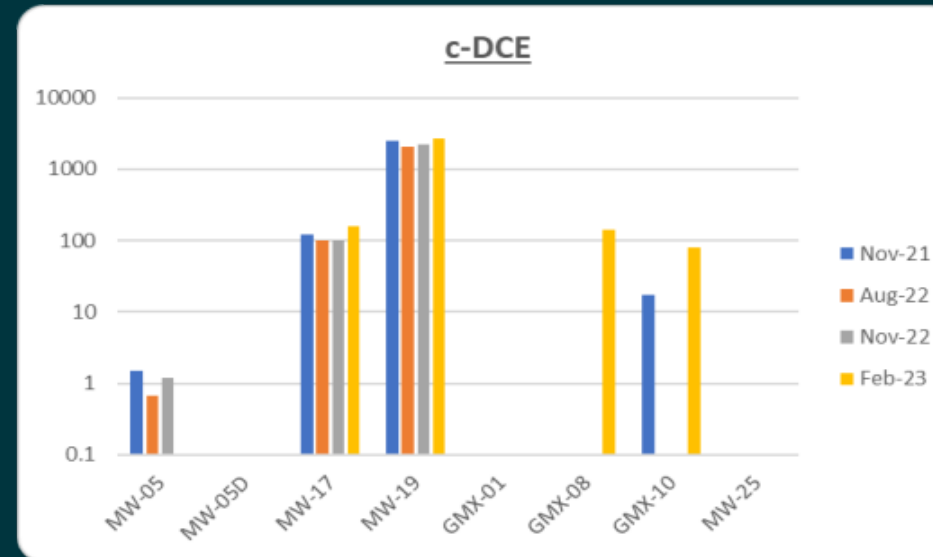
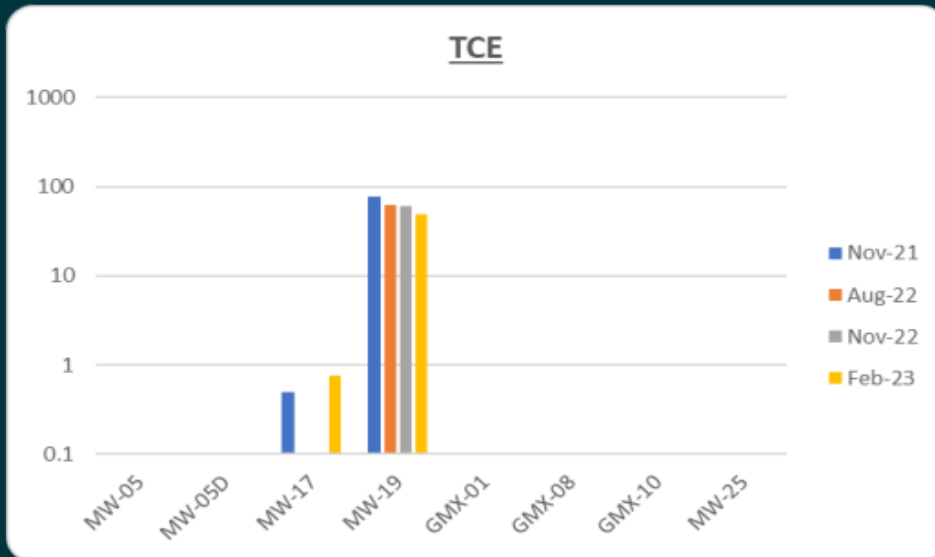
DO - Shallow



ORP - Shallow



- pH values consistent pre- and post GWRS shutdown
- DO values more favorable following GWRS shutdown
- ORP values all negative following GWRS shutdown
- No detrimental impact from GWRS shutdown

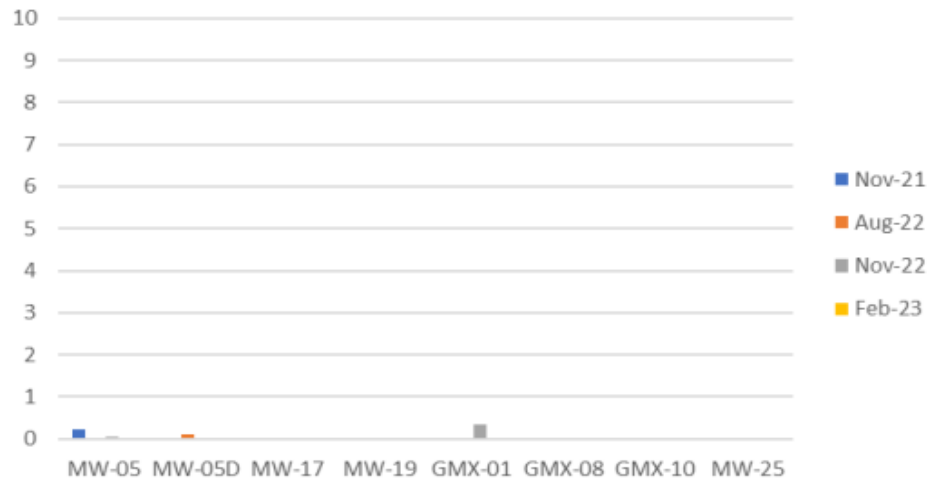


*All
concentrations
in µg/L*

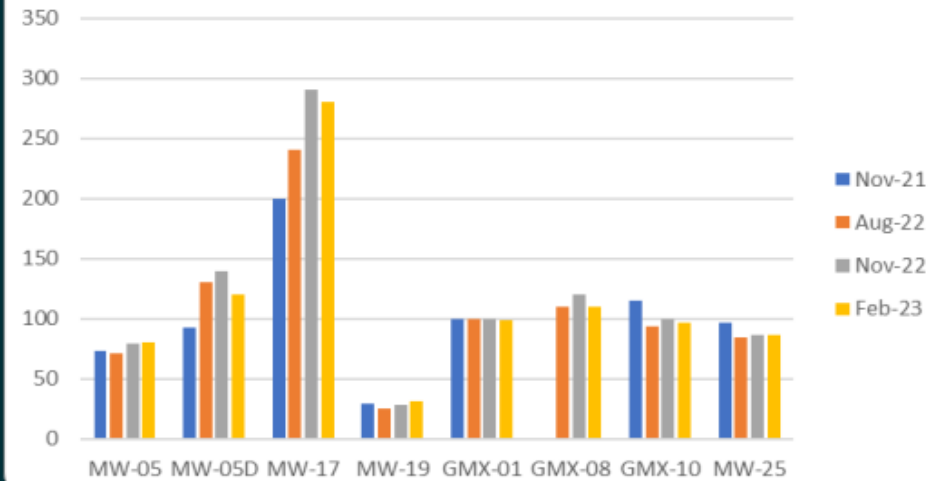
- Values consistent from Nov-21 thru Feb-23
- ↓ in TCE at MW-19
- ↓ in c-DCE; steady downgradient
- Same for VC
- Slight ↑ in VC at GMX-08/-10; attributable to ongoing degradation

TCE: trichloroethene
c-DCE: cis-1,2-dichloroethene
t-DCE: trans-1,2-dichloroethene
VC: vinyl chloride

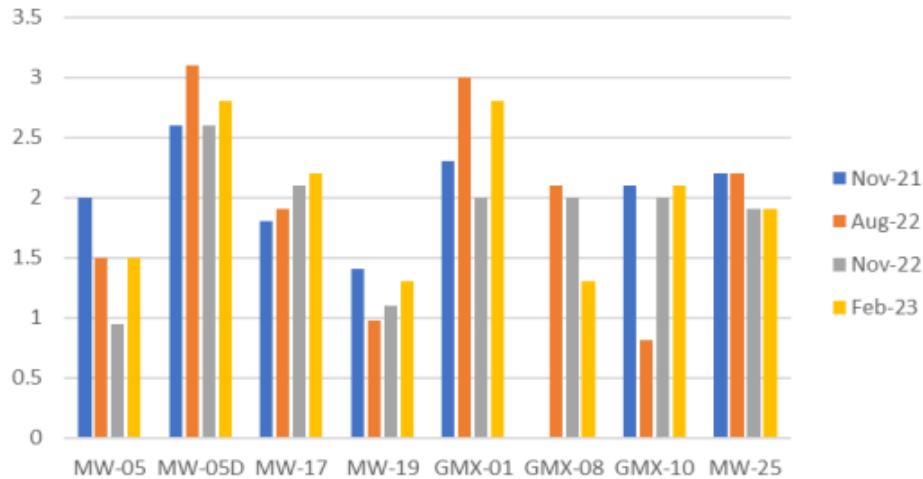
Nitrate as N



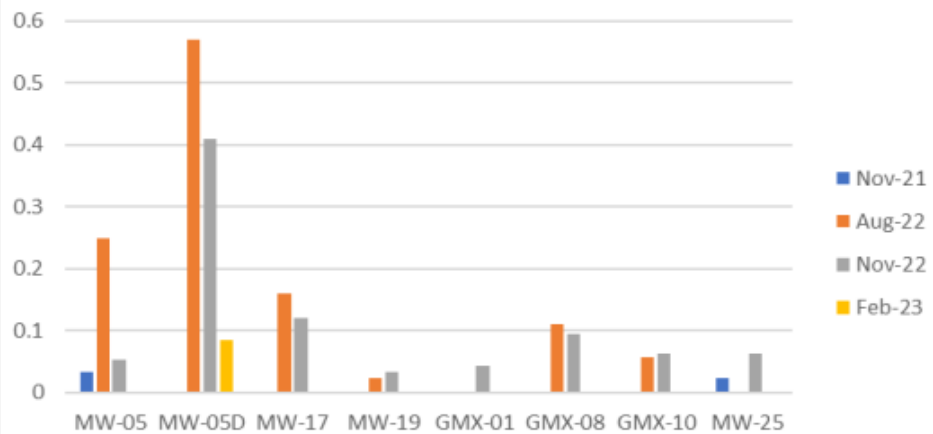
Sulfate



Ferric Iron



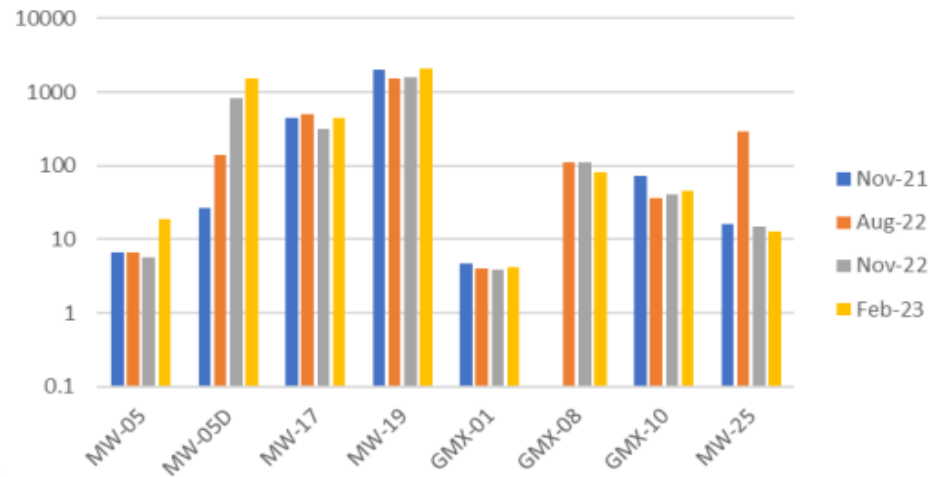
Ferrous Iron



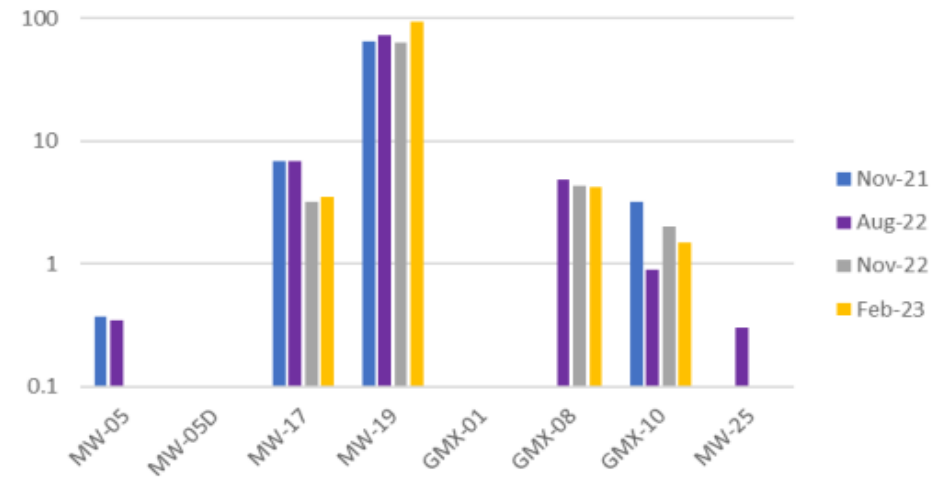
- Nitrogen is generally depleted
- Sulfate decreases from upgradient to downgradient
- Ferrous iron (Fe+2) has been detected in downgradient MWs
- Reducing conditions conducive to reductive dechlorination maintained
- Further support field parameters results

Concentrations in mg/L

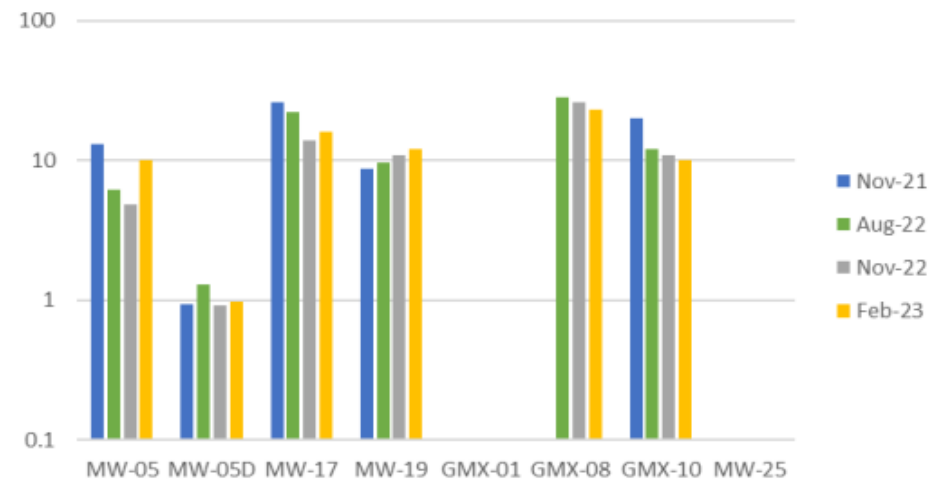
Methane



Ethane



Ethene



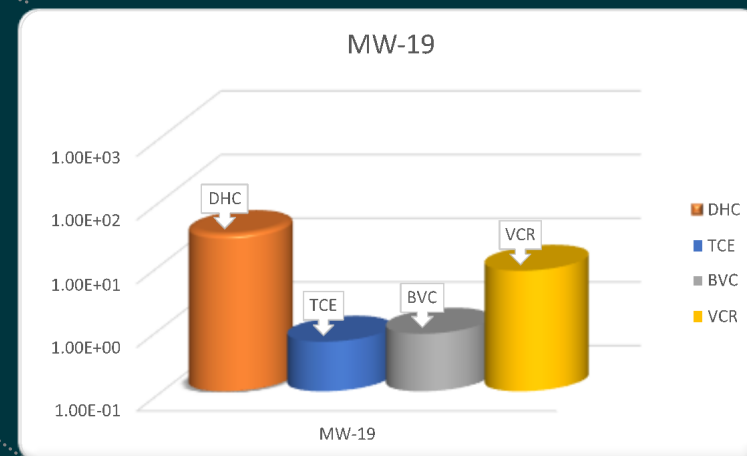
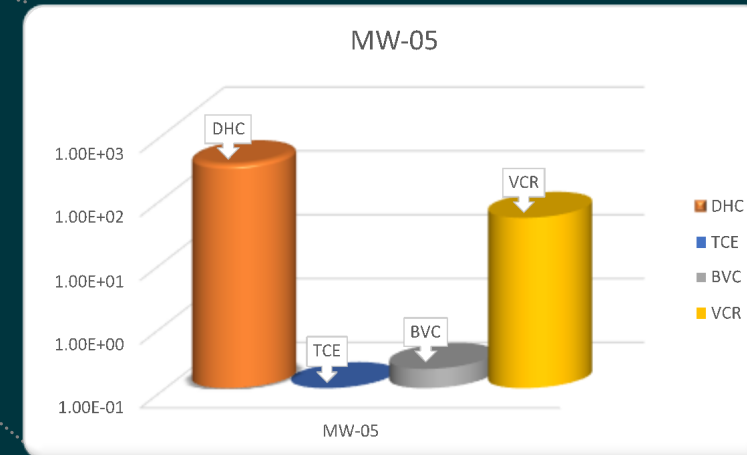
- Note detections of ethane at GMX-08
- Note increasing ethane at MW-19
- Note detections of ethene at GMX-08 following GWRS shutdown
- Ethane and ethene detections support ongoing reductive dechlorination

- Methane detected from upgradient to downgradient; concentration relatively stable
- Ethane and ethene detected from upgradient to downgradient; relatively stable; indicating ongoing reductive dechlorination

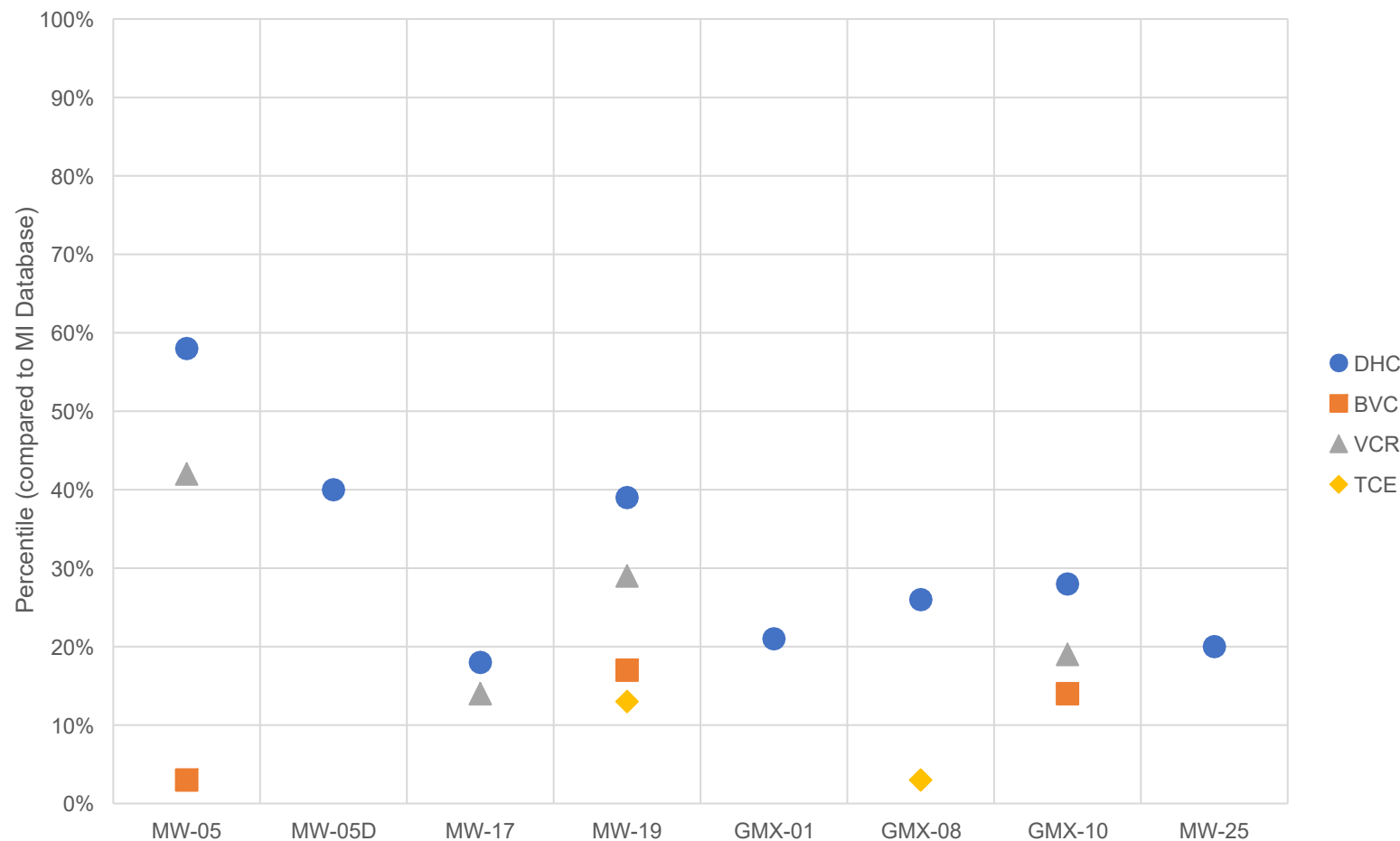
All concentrations in
µg/L

Microbial community presence facilitates ongoing degradation

- DHC/func. genes present across the impacted groundwater plume (i.e., upgradient → downgradient)
- DHC/func. genes more widespread than baseline event

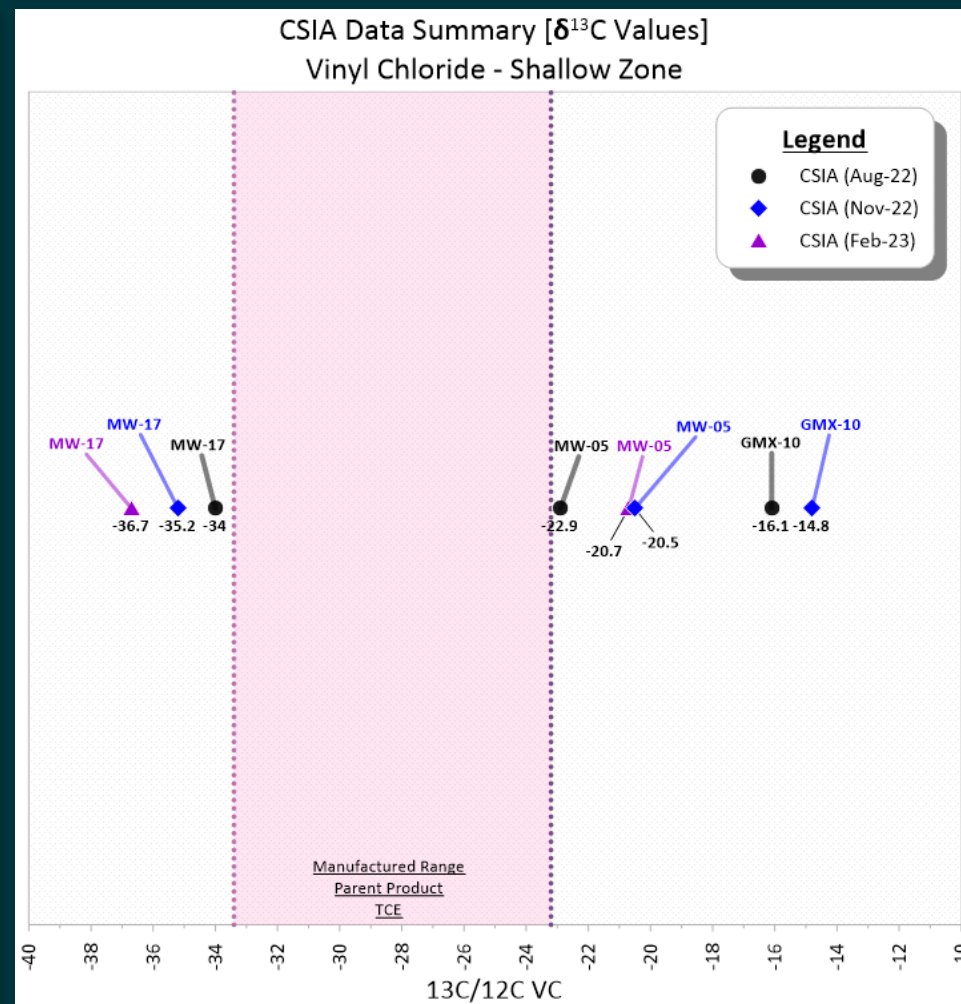
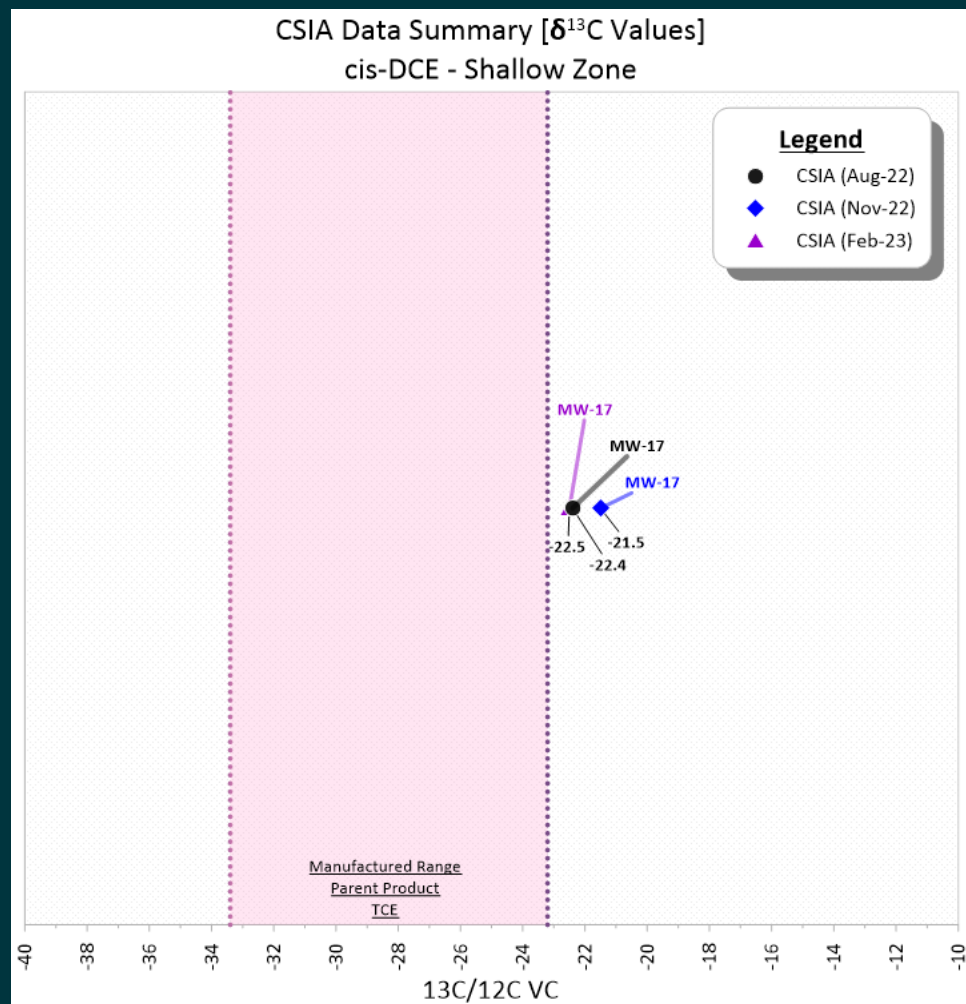


Units in
copies/mL



Feb-2023 Results

- MI qPCR Database used to evaluate DHC/BVC/VCR/TCE against other sites
- Reported DHC populations are higher than 19-58% of sites in MI Database
- Functional reductase genes are present at lower percentile rankings (ND-42% higher than other sites)
- Functional genes more prevalent in Shallow Zone
- Presence/detection of DHC and functional genes is supportive of ongoing reductive dechlorination



- $\delta^{13}\text{C}$ plots illustrate enrichment for c-DCE and /VC
- Interpretations based on degradation products (c-DCE/VC) CSIA results
- Primarily in upgradient and mid plume areas
- Lack of enrichment at MW-17 attributable to formation of VC as part of ongoing reductive dechlorination
- Observed enrichment of c-DCE / VC is indicative of ongoing reductive dechlorination

MNA Demonstration to-date indicates that shutdown of the GWRS has not been detrimental to ongoing natural attenuation processes

Data supports permanent shutdown of GWRS and transition to alternative NA remedy

- Supported by multiple LOEs
- Addition of microbiological LOEs have been essential in bolstering natural attenuation demonstration

Path Forward

- Continue Enhanced Quarterly GW Monitoring (through 2023)
- Looking at BioPIC and CSIA data to estimate degradation rates
- Looking at potential in-situ remedies to address the mid-plume area where c-DCE and VC accumulation has been observed
- Update Plume Analytics
- Final Evaluation

06

QUESTIONS



THANK YOU!



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