

A large blue geometric graphic consisting of overlapping triangles and lines, located in the top-left corner of the slide.

Analysis and Interpretation of Geochemical, Isotopic, Hydrogeologic, and Direct-Sensing Data to Support CSM Development for a Complex Site



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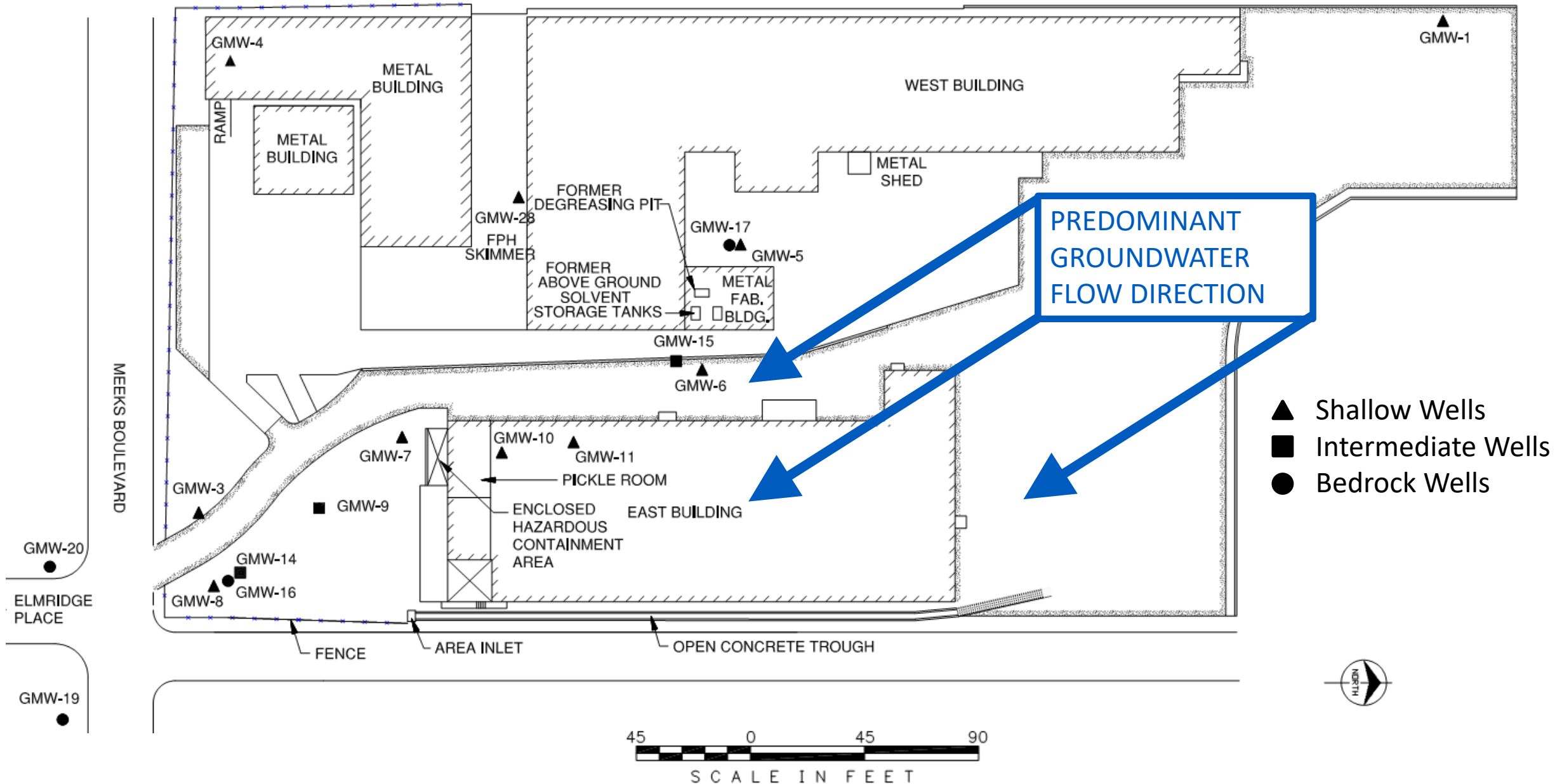
April 16, 2019



Site Location



Site Layout

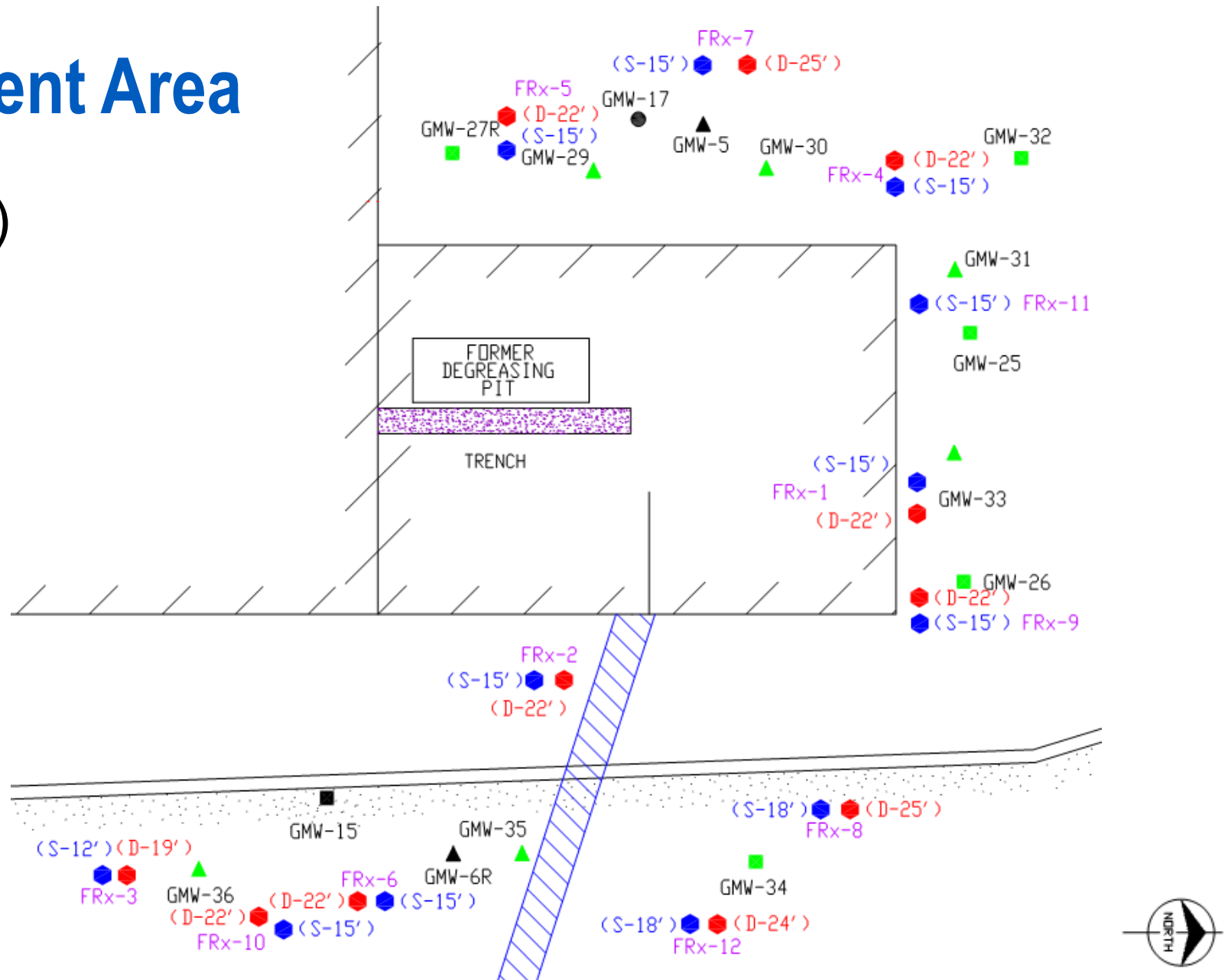


Primary ISCO Treatment Area

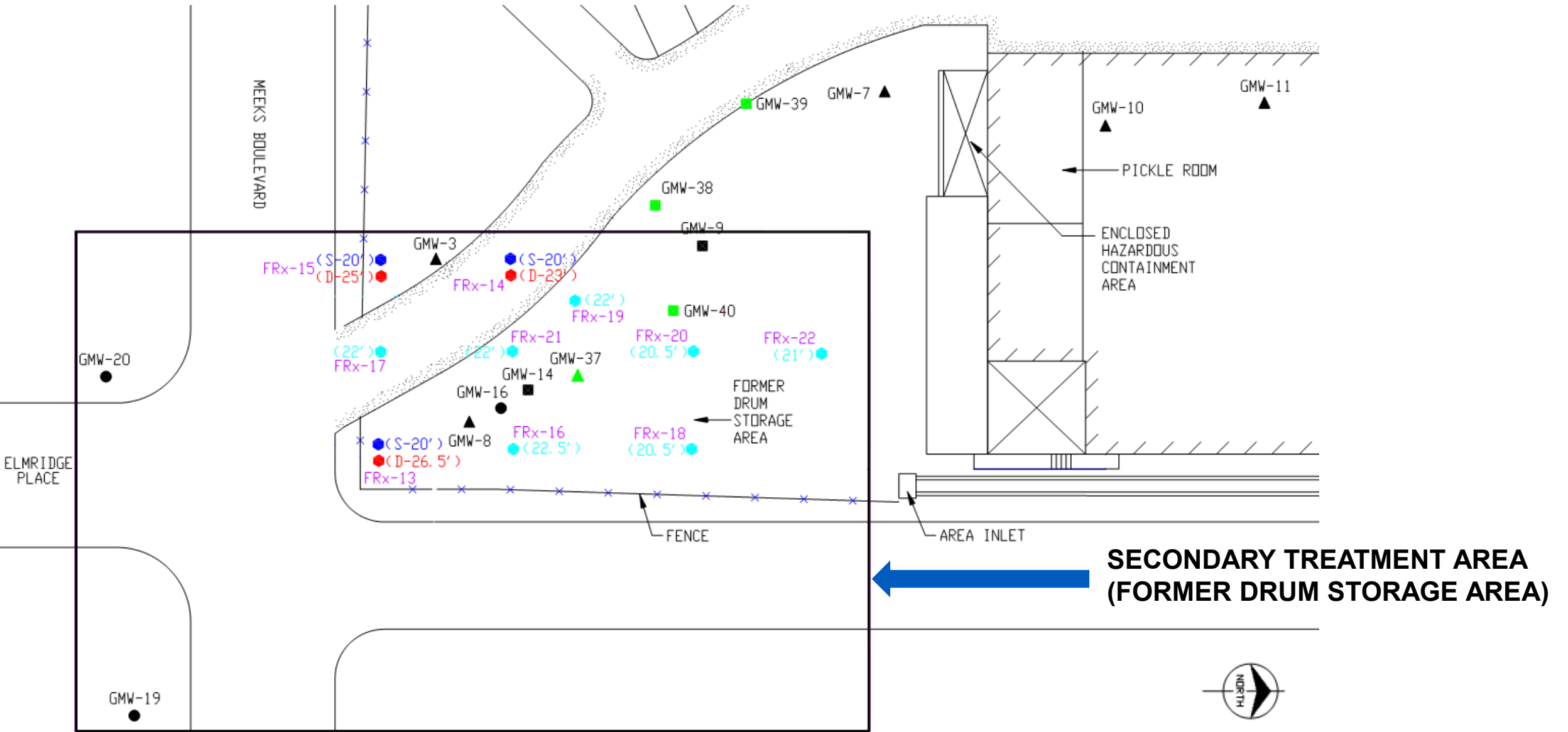
► Degreaser Area (2004)

- Injection Trench
- Injection Wells
- Hydraulic Fractures

► Primarily Potassium Permanganate



Secondary ISCO Treatment Area (2004)



Problem – Source and Plume Investigation

- ▶ Identify and characterize sources
- ▶ Define extent of impacts in three dimensions
- ▶ Characterize major fate and transport mechanisms affecting historical, present, and future contaminant migration to assist with evaluation and design of remedy.

Phased Approach

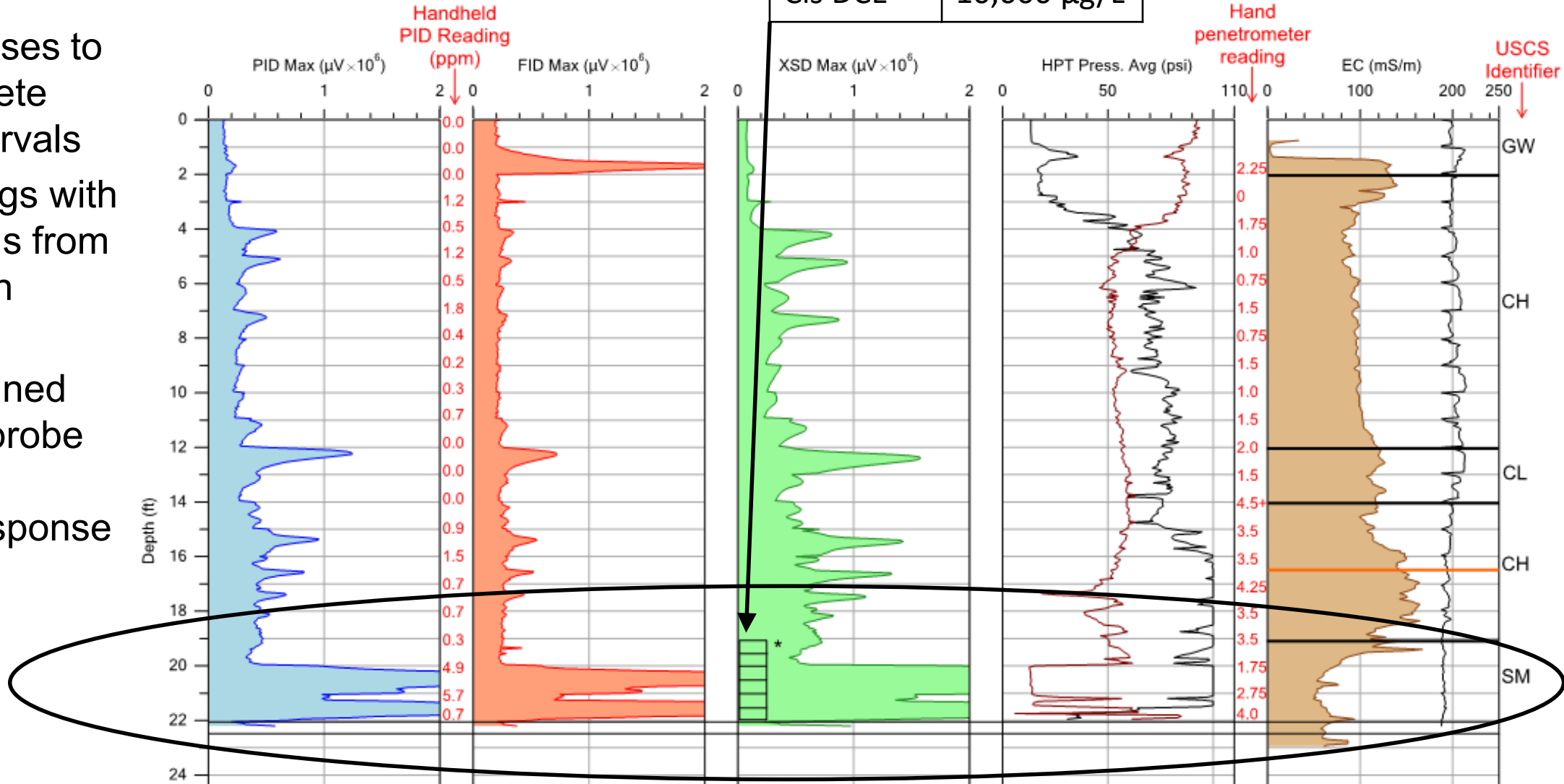
- ▶ High-resolution site characterization (HRSC) borings and discrete soil and groundwater sampling (focused on sources and unconsolidated impacts)
- ▶ Monitoring well installation targeting multiple vertical intervals
- ▶ Use Environmental Sequence Stratigraphy (ESS) approach to evaluate borings
- ▶ Groundwater sampling for extended suite of analyses
 - COC
 - Major Cations and Anions
 - Compound Specific Isotope Analysis (CSIA)
 - Biological population quantification analyses

HRSC Borings

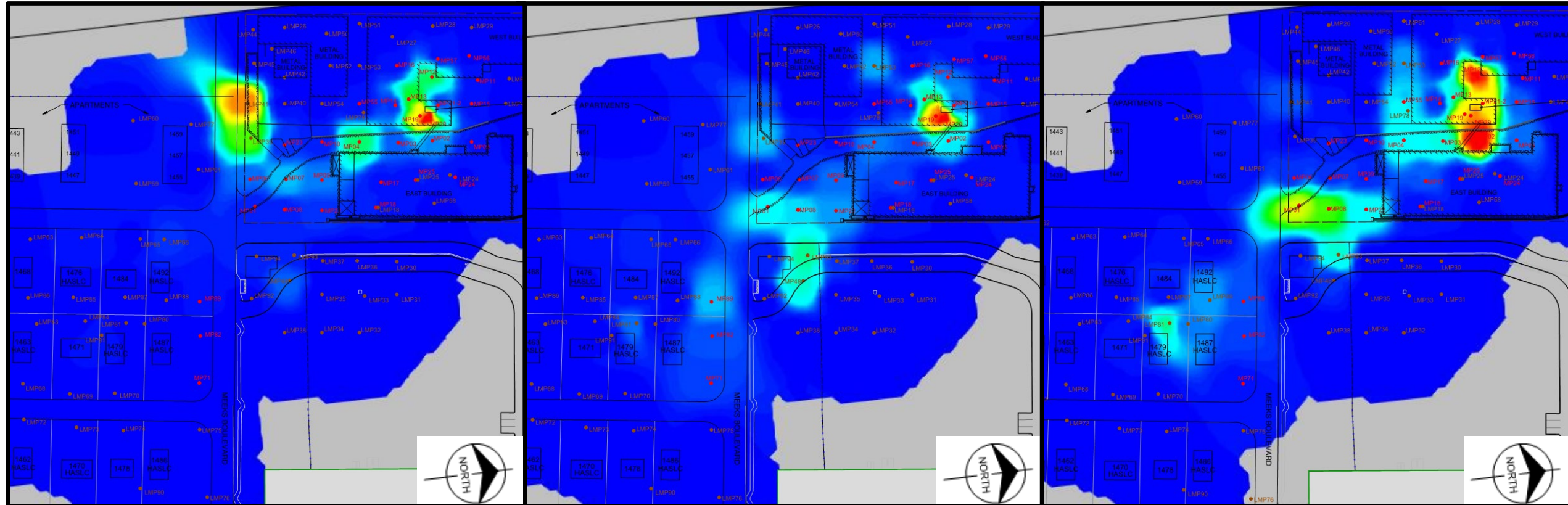
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PCE	4,100 µg/L
TCE	2,400 µg/L
Cis DCE	10,000 µg/L

- ▶ Use responses to target discrete sample intervals
- ▶ Annotate logs with observations from confirmation borings
- ▶ Coarse grained zone near probe refusal with greatest response further from source



XSD Responses

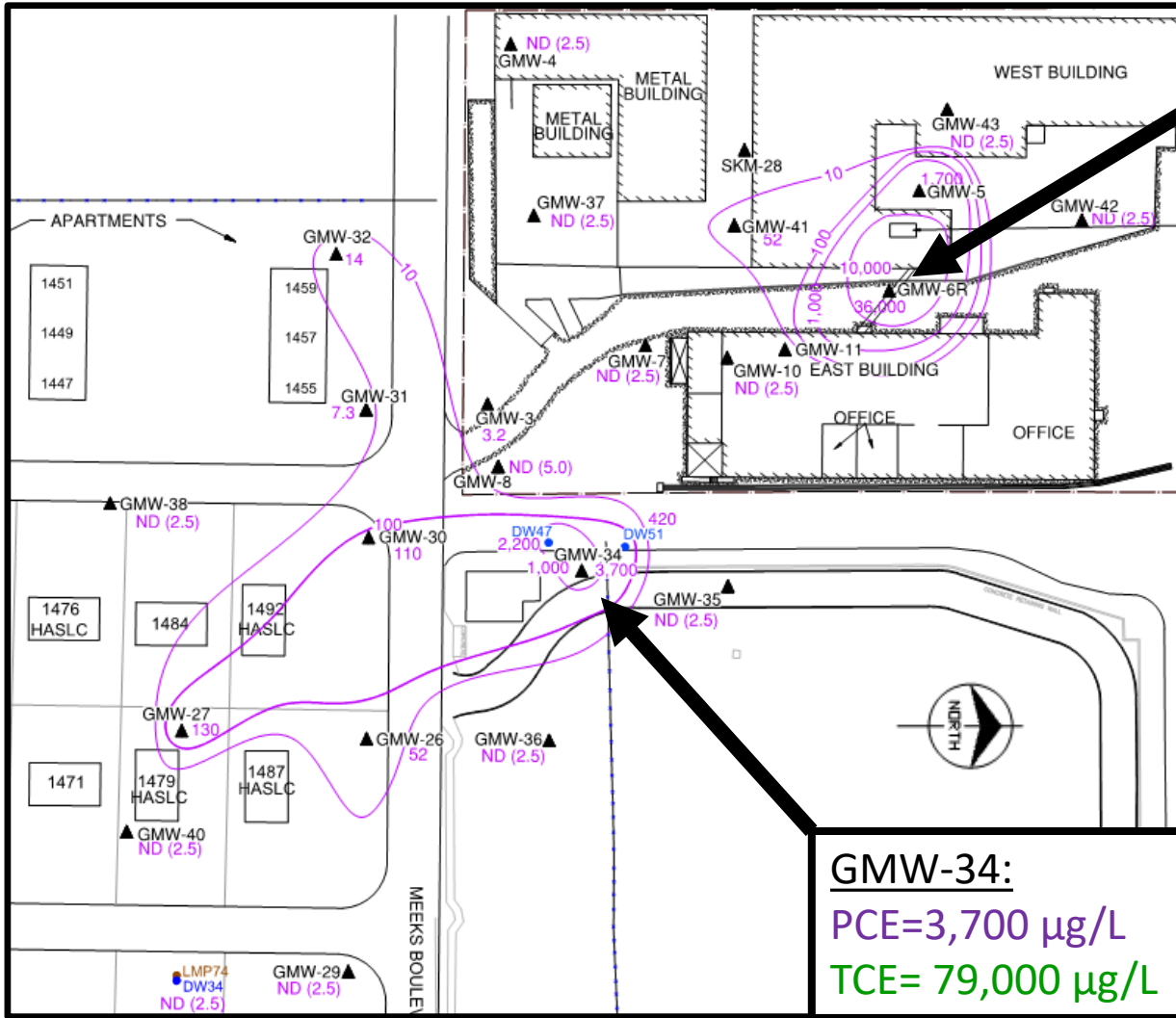


**VADOSE
ZONE**

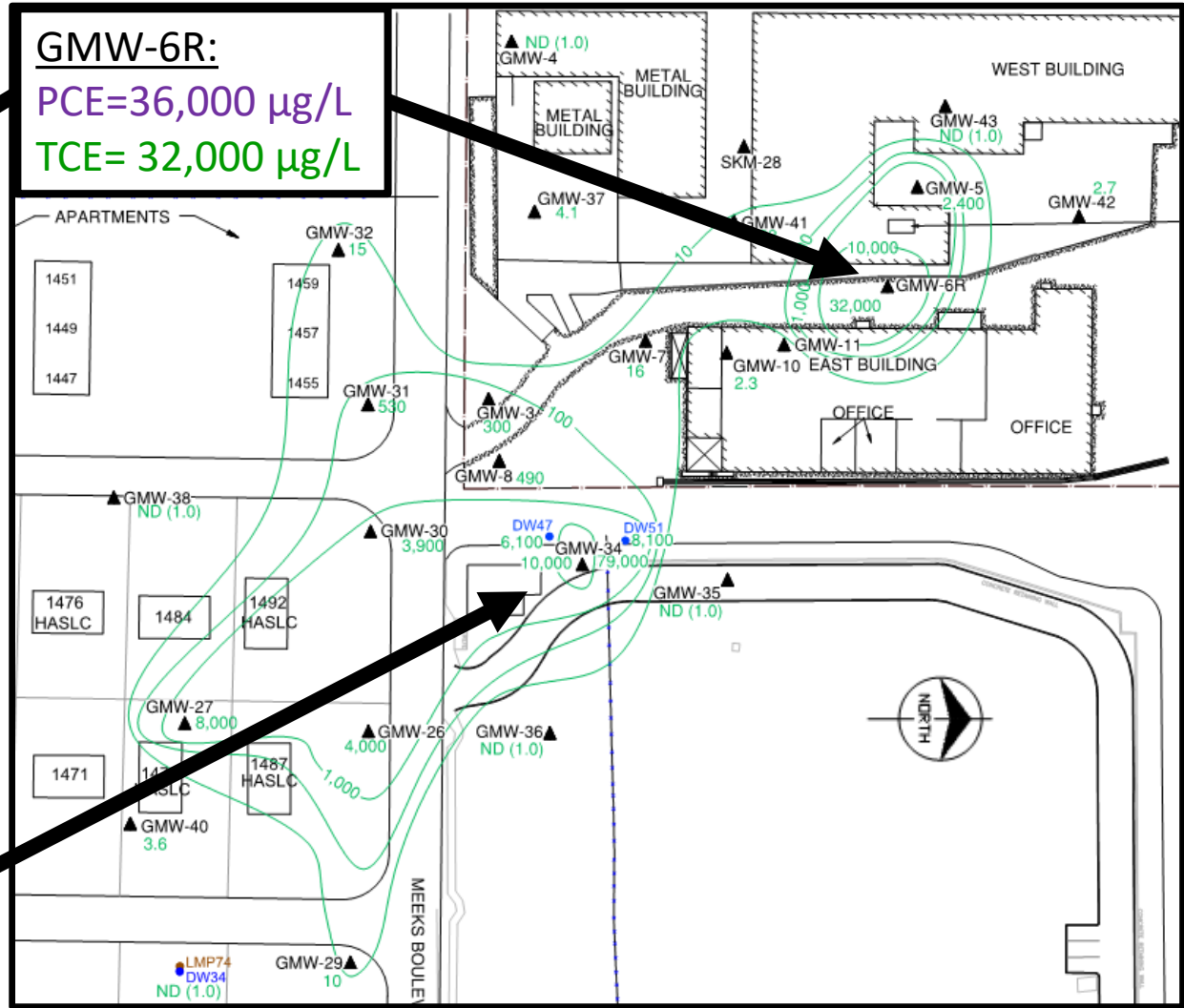
**SATURATED
LOESS**

**SATURATED
TRANSITION ZONE**

Loess Wells

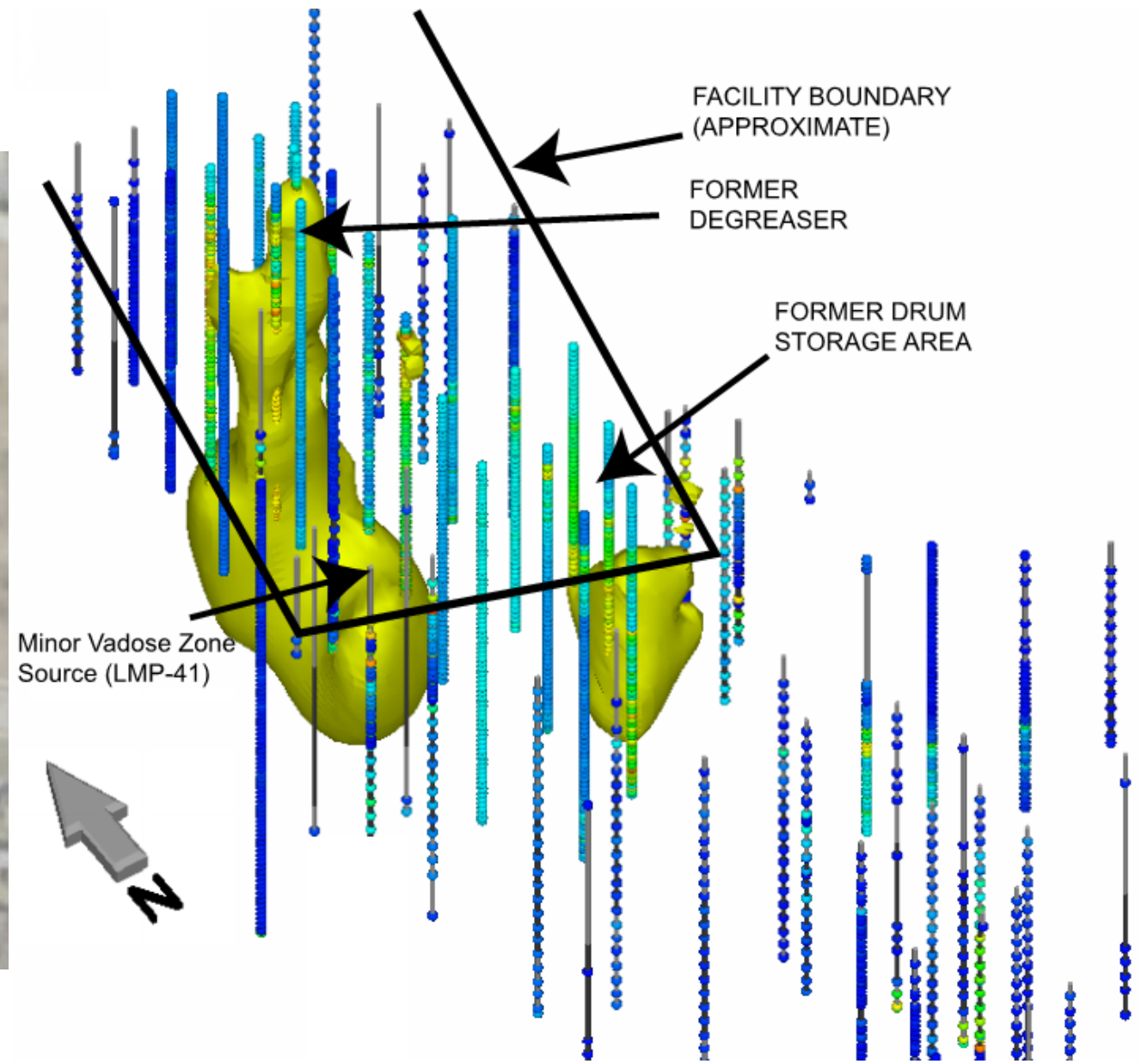


PCE

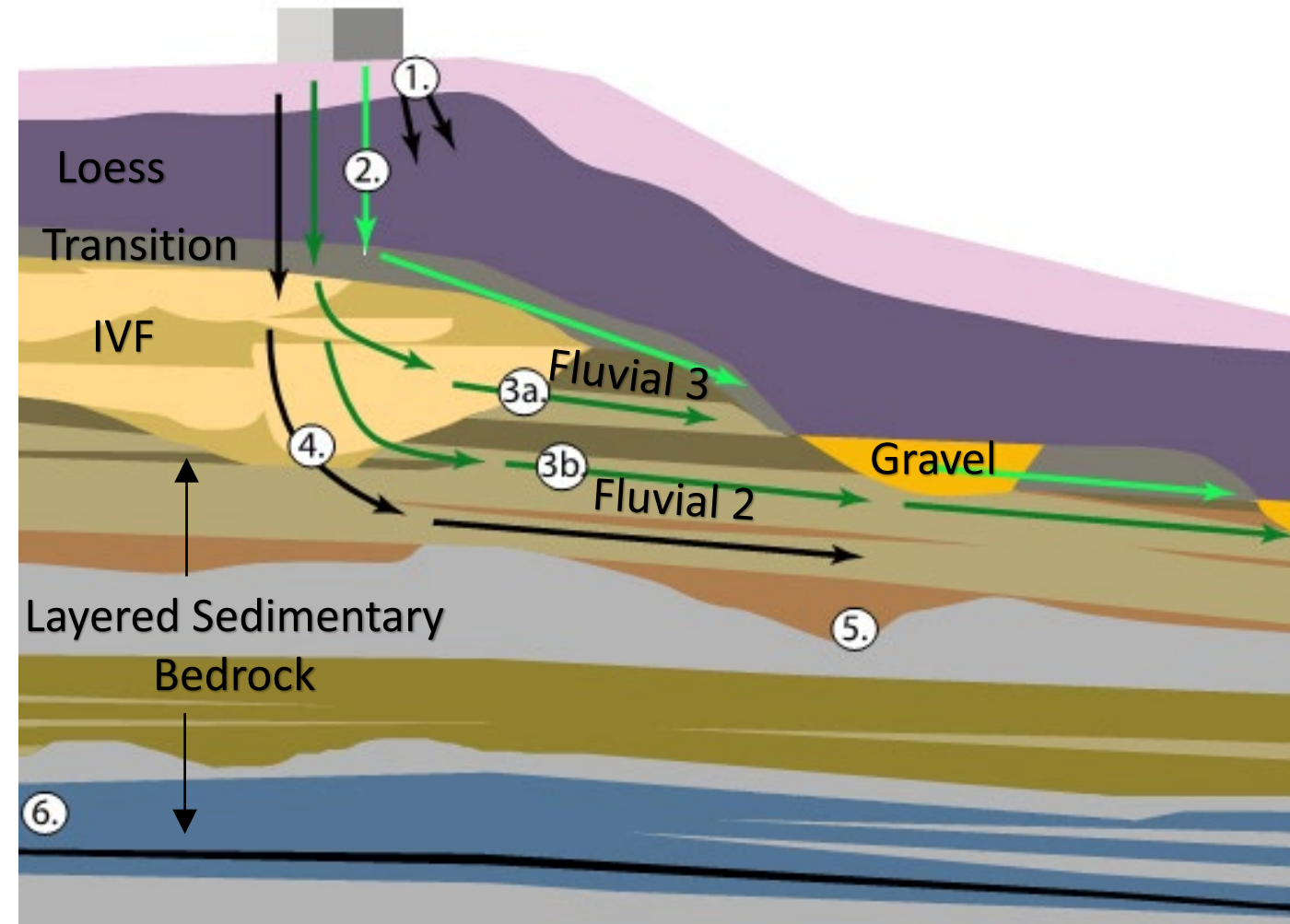


TCE

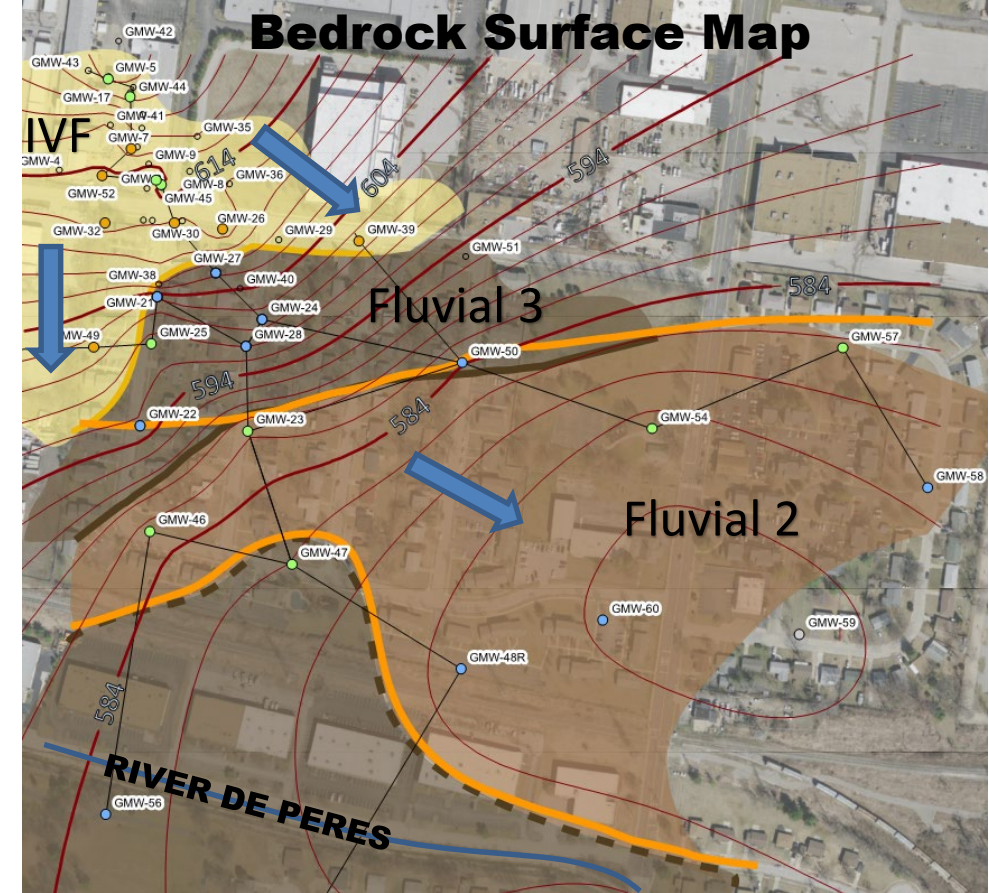
XSD Responses



Environmental Sequence Stratigraphy

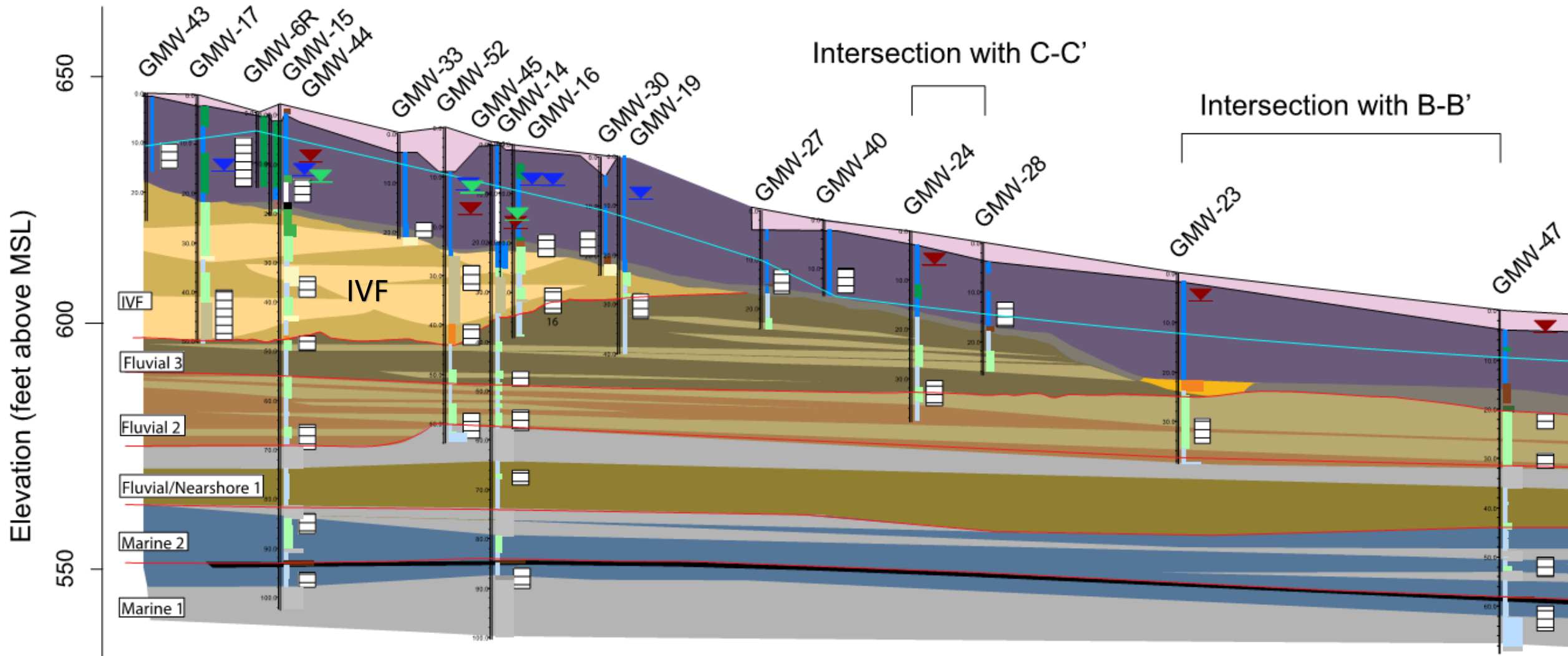


Conceptual Profile View

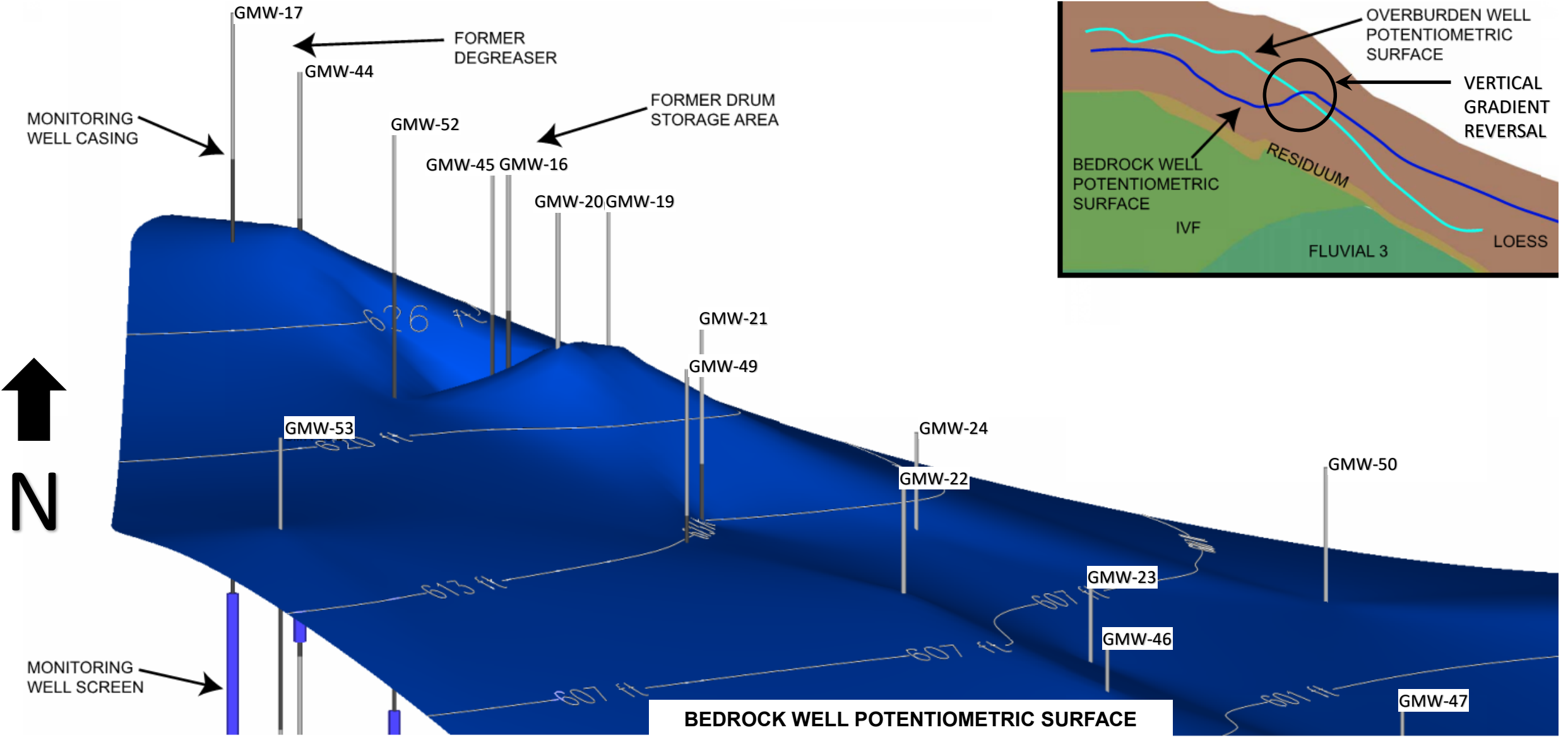


- ▶ Contaminant migration predominantly vertically downward through loess overburden
- ▶ Identified Incised Valley Fill (IVF) as major contaminant transport pathway.
- ▶ Layered sedimentary bedrock features promote lateral migration while minimizing vertical migration.
- ▶ Limestone thickness inhibits vertical migration

Hydrogeologic Data Evaluation



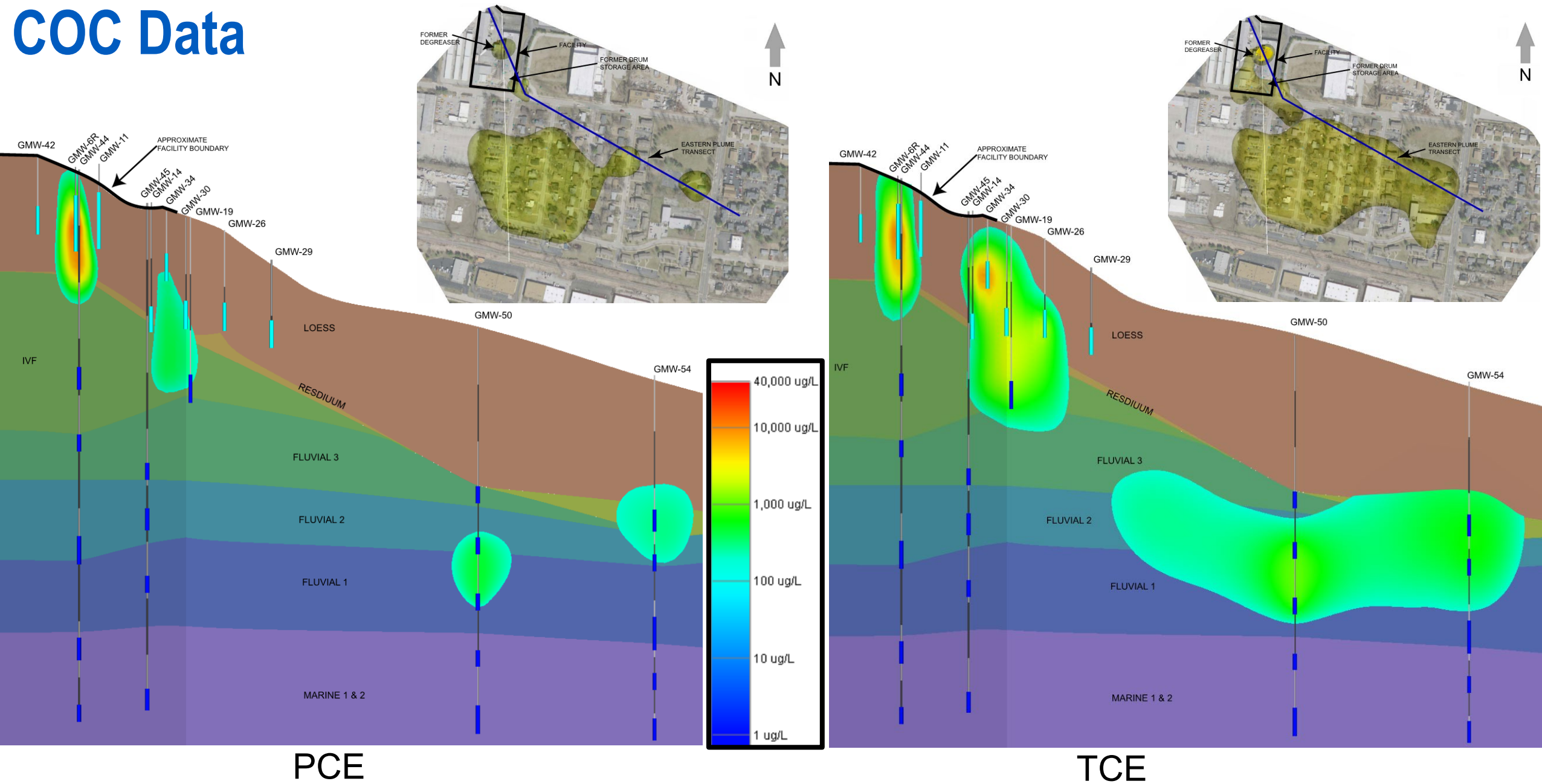
Hydrogeologic Data Evaluation



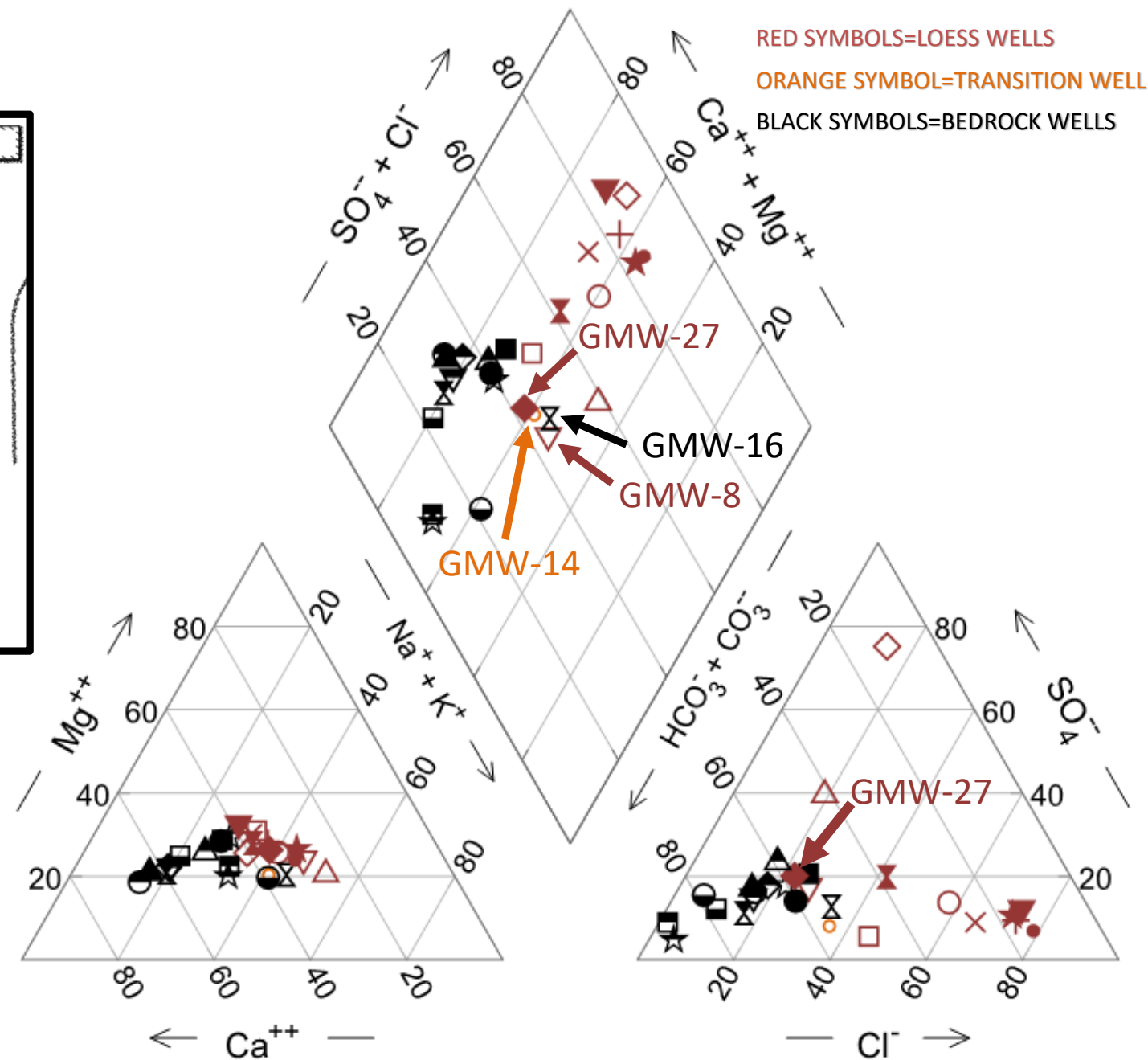
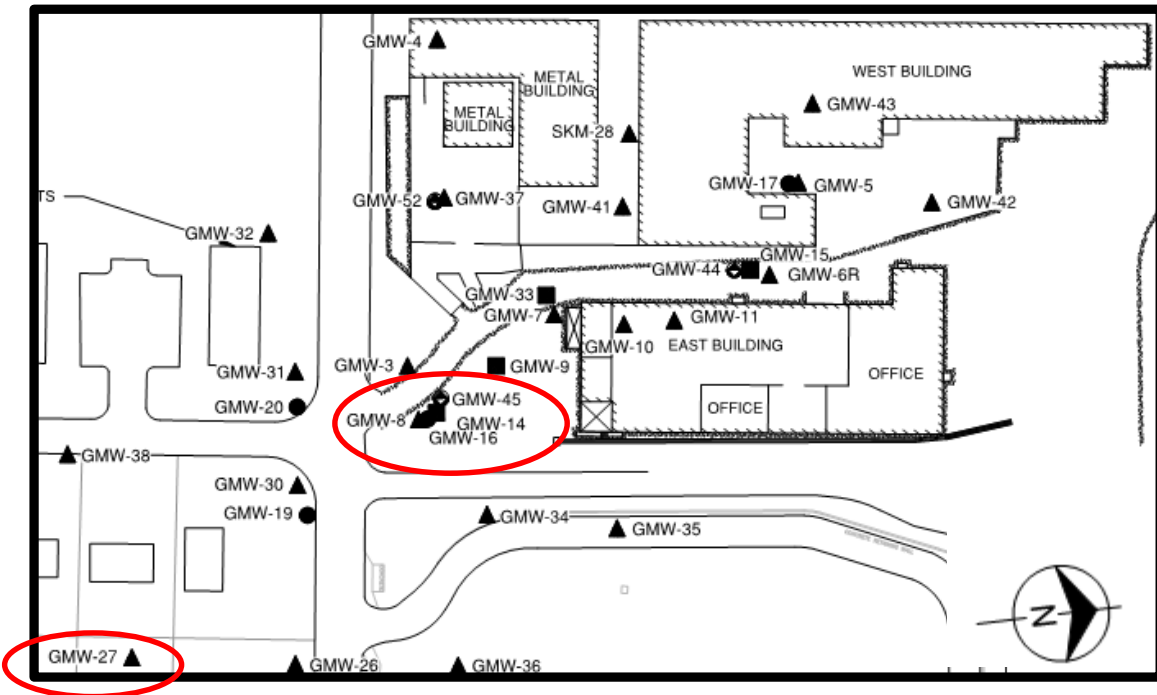
Suite of Analyses

- ▶ COC
- ▶ Major Cations and Anions
- ▶ Compound Specific Isotope Analysis (CSIA)
- ▶ Biological population quantification analyses

COC Data

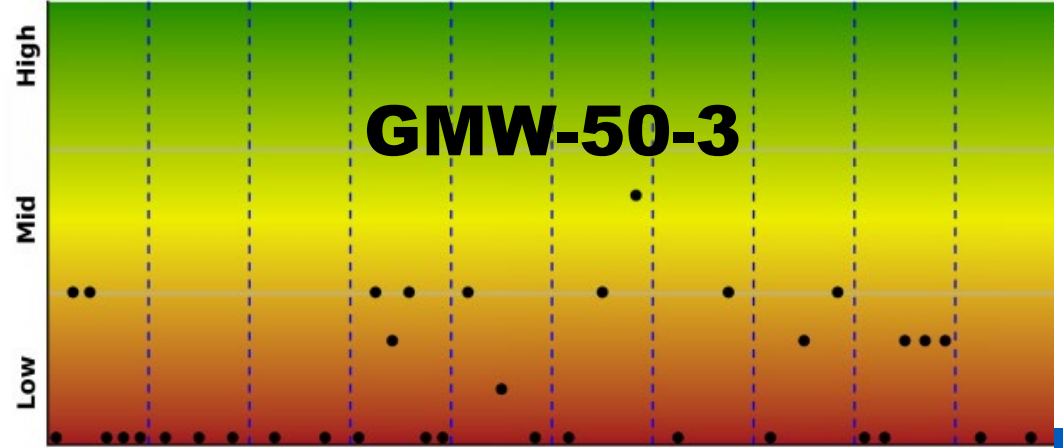
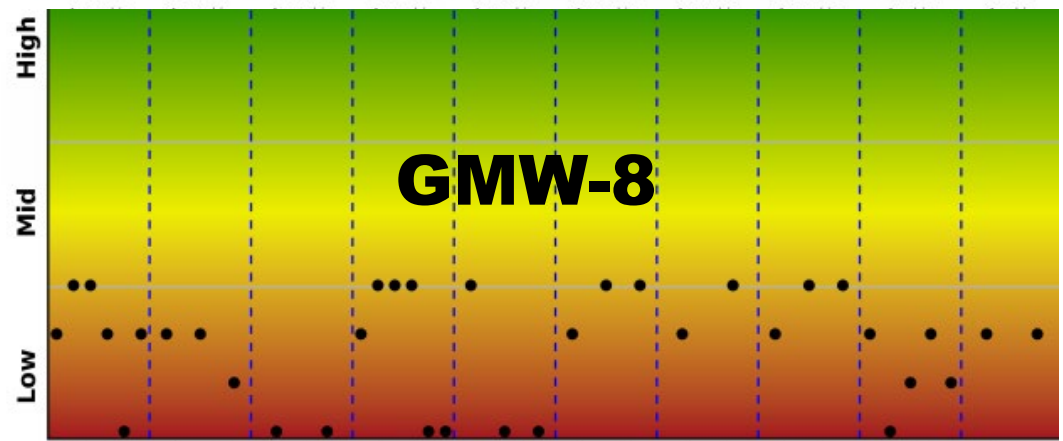
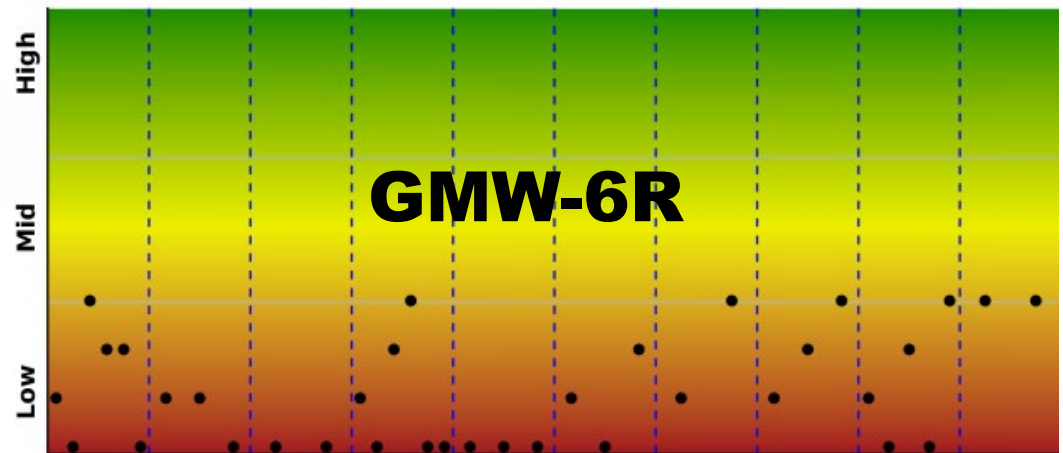
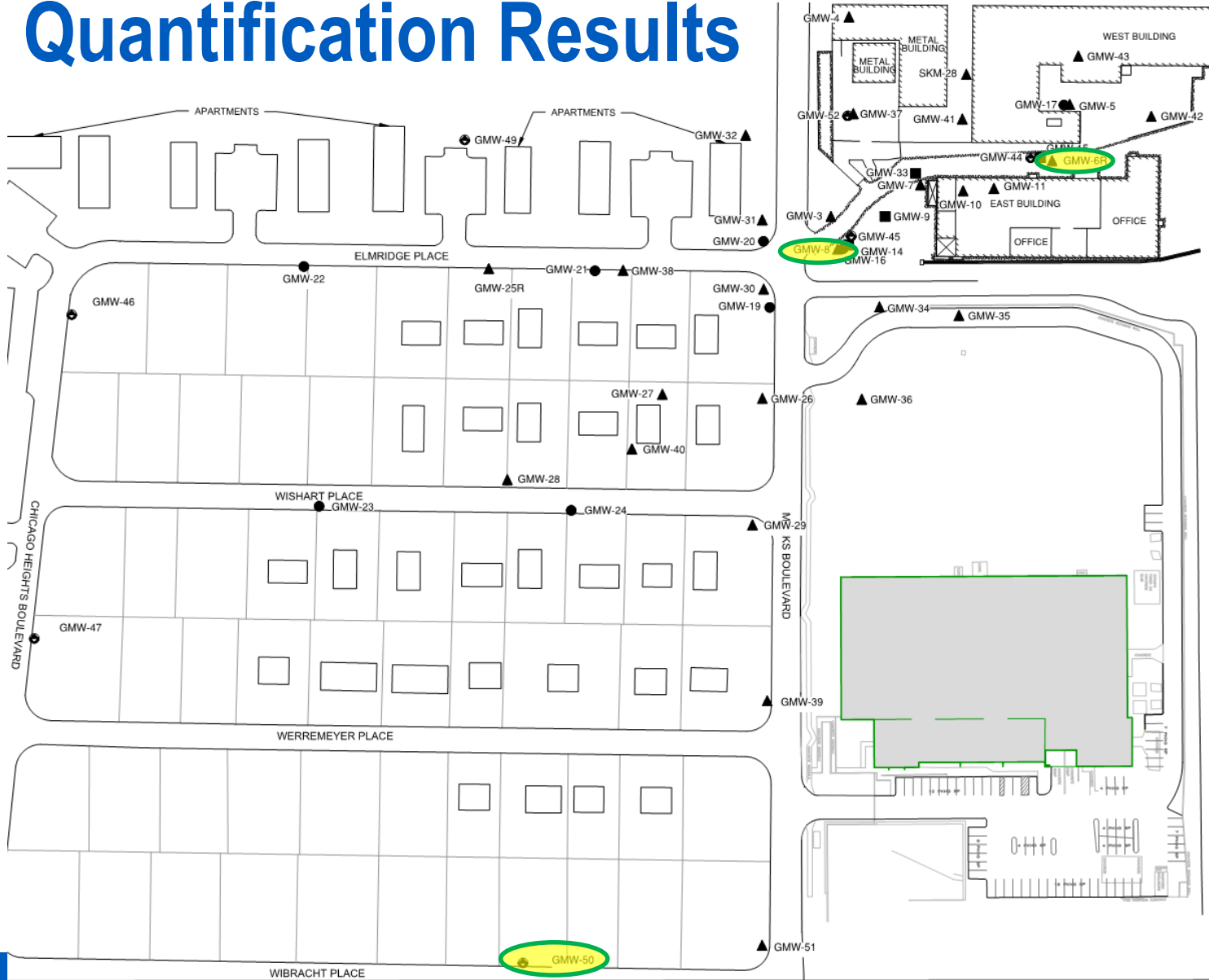


Major Cations and Anions



- ▶ Loess and bedrock wells typically plot in distinctly different areas
- ▶ Major exceptions are GMW-27 and wells near SE corner of facility where zone of mixing appears to exist

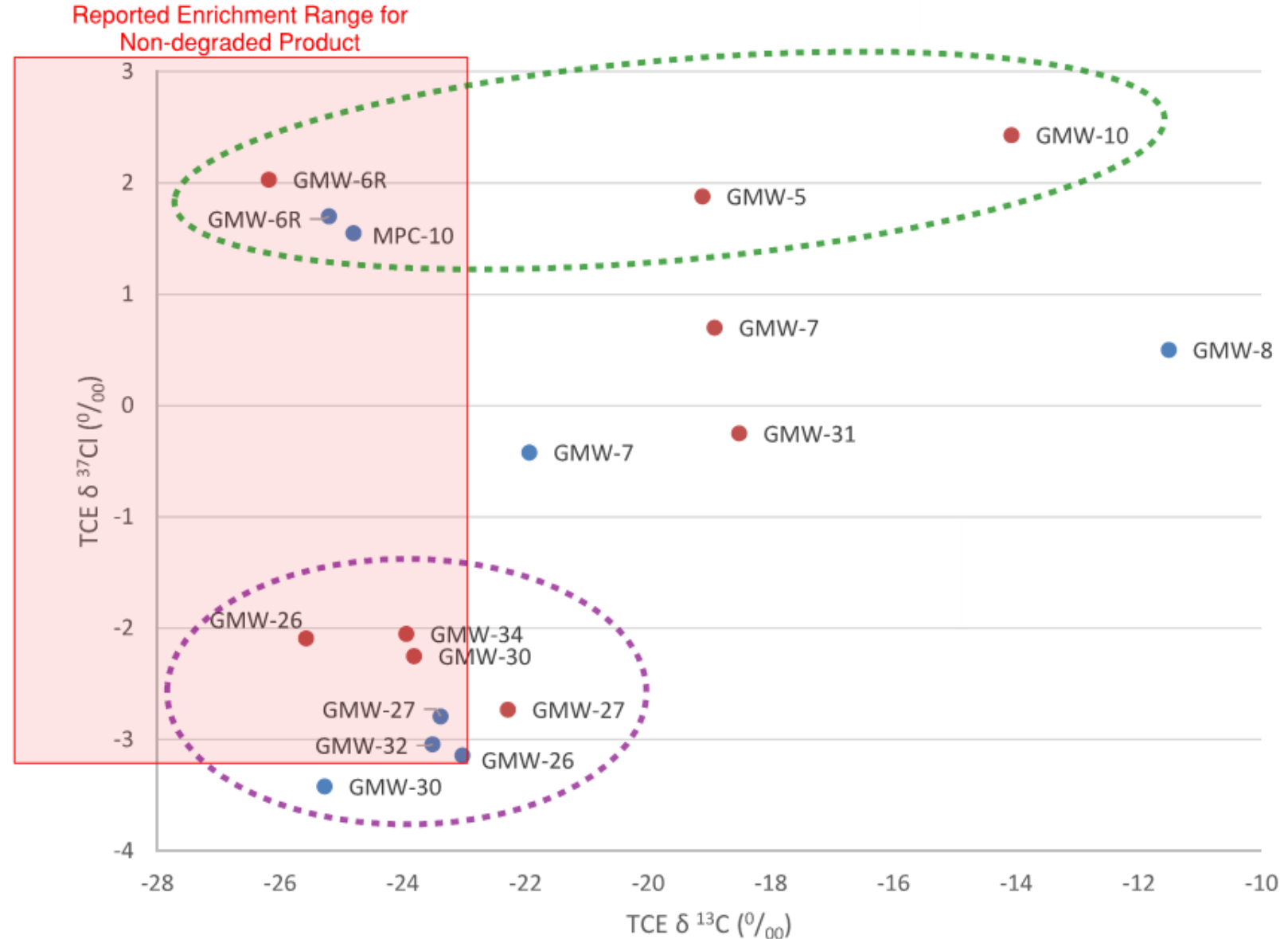
Microbial Population Quantification Results



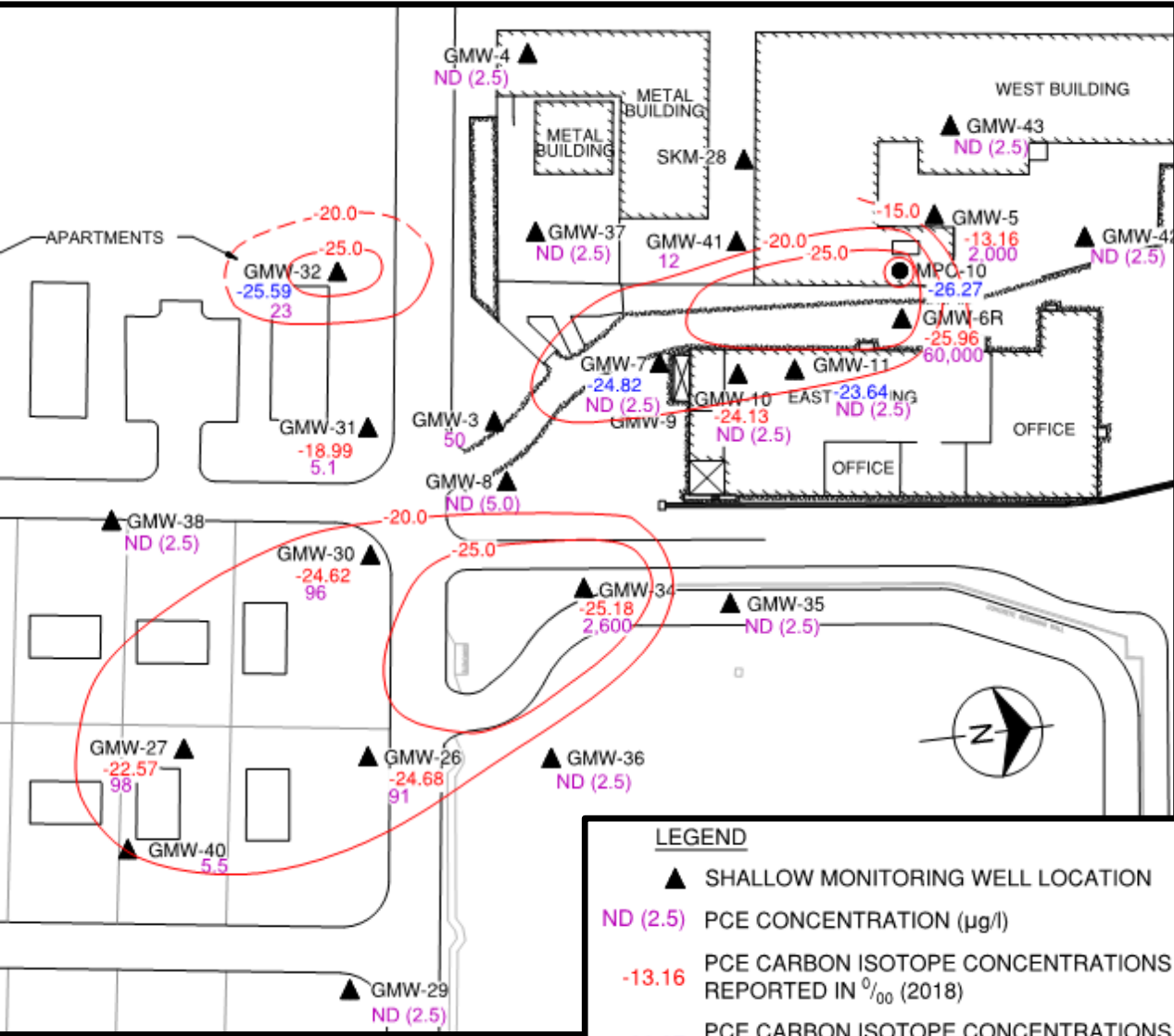
CSIA Results

- ▶ Wells near and immediately down gradient of degreaser generally exhibit different isotopic signatures than those near or immediately down gradient of the former drums storage area

TCE DATA - LOESS WELLS

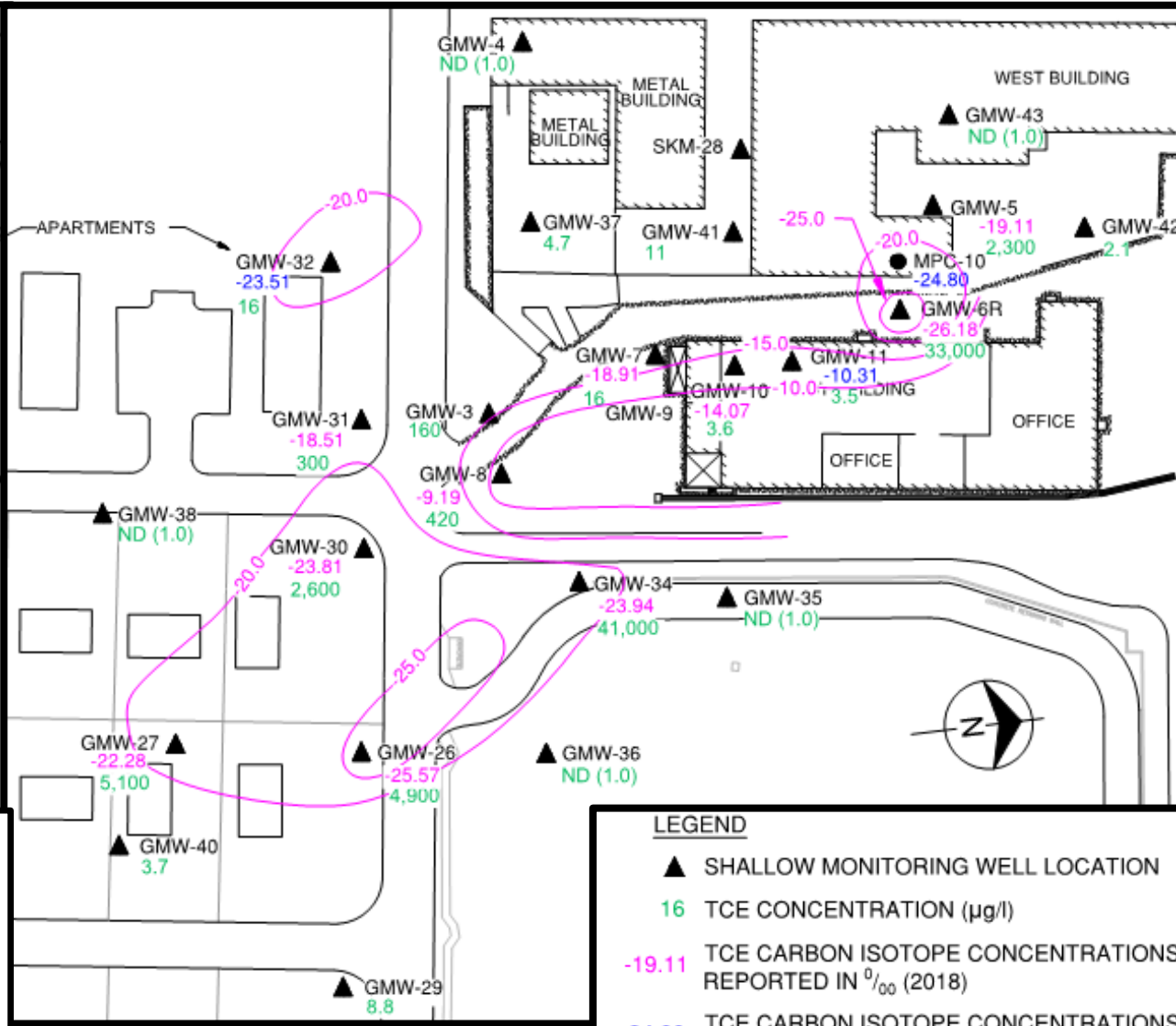


CSIA Results – Loess Wells



LEGEND

- ▲ SHALLOW MONITORING WELL LOCATION
- ND (2.5) PCE CONCENTRATION (µg/l)
- 13.16 PCE CARBON ISOTOPE CONCENTRATIONS REPORTED IN ‰ (2018)
- 26.27 PCE CARBON ISOTOPE CONCENTRATIONS REPORTED IN ‰ (2014)
- 20.0 CARBON ISOTOPE ISOMETRIC CONTOURS

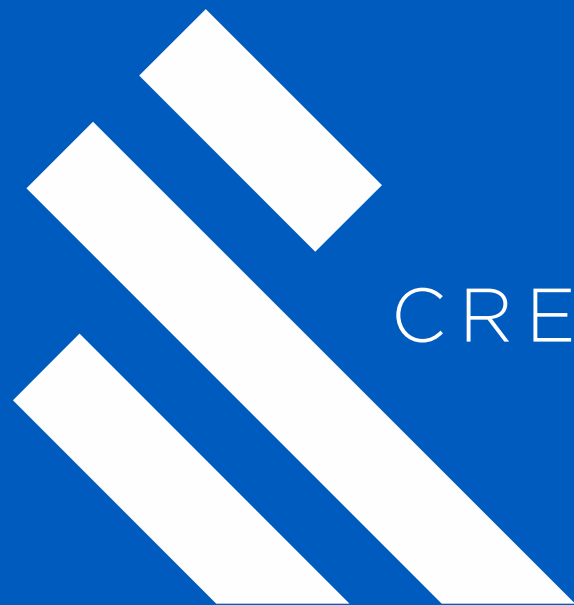


LEGEND

- ▲ SHALLOW MONITORING WELL LOCATION
- 16 TCE CONCENTRATION (µg/l)
- 19.11 TCE CARBON ISOTOPE CONCENTRATIONS REPORTED IN ‰ (2018)
- 24.80 TCE CARBON ISOTOPE CONCENTRATIONS REPORTED IN ‰ (2014)
- 20.0 CARBON ISOTOPE ISOMETRIC CONTOURS

Conclusions

- ▶ HRSC borings identified multiple sources and made delineation of impacts more efficient;
- ▶ Geologic framework identified potential preferential pathways;
- ▶ Hydrogeologic data supports migration hypotheses;
- ▶ Source locations and stratigraphy explain plume geometries;
- ▶ Moderate biodegradation is occurring at select areas of Site where majority of contaminant mass remains;
- ▶ Location of sources and process controlling fate and transport of those impacts provide framework to target an efficient remedial strategy



CREATE AMAZING.