



REGENESIS[®]
BATTELLE

Dynamic Remediation

Furthering Hydraulic Characterization: Visual Mapping of Injection Data

Andrew Kavanagh, LPG
Project Manager II
REGENESIS

Outline

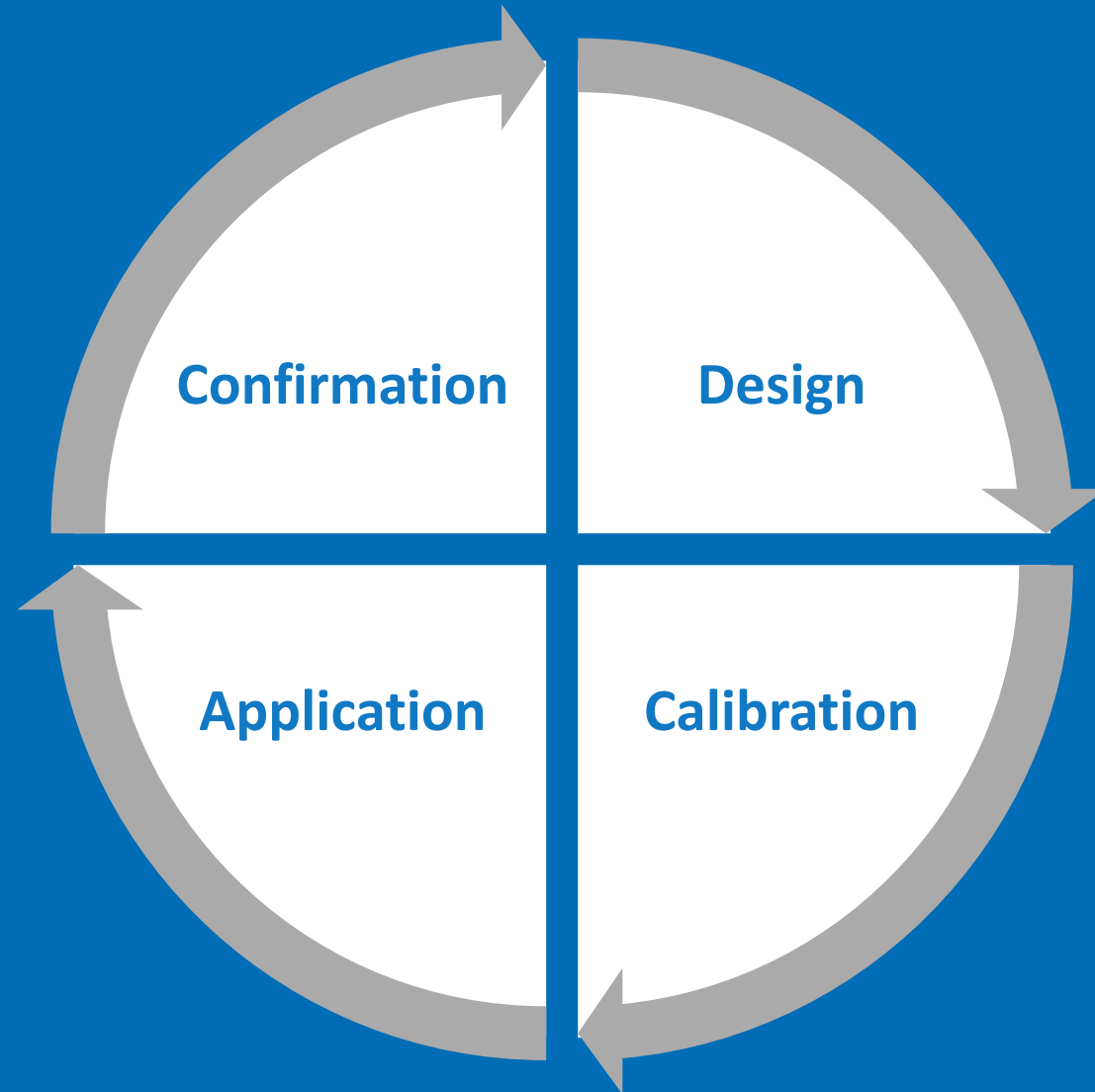
Intro to Dynamic Remediation

Challenges with Injection Projects

Managing Injection Data Through Visual Mapping

Summary

Dynamic Remediation Process



Design

Field-Ready Remedial Design Application in Collaboration with Technical Services

RRS is intimately familiar and engaged with remedial design

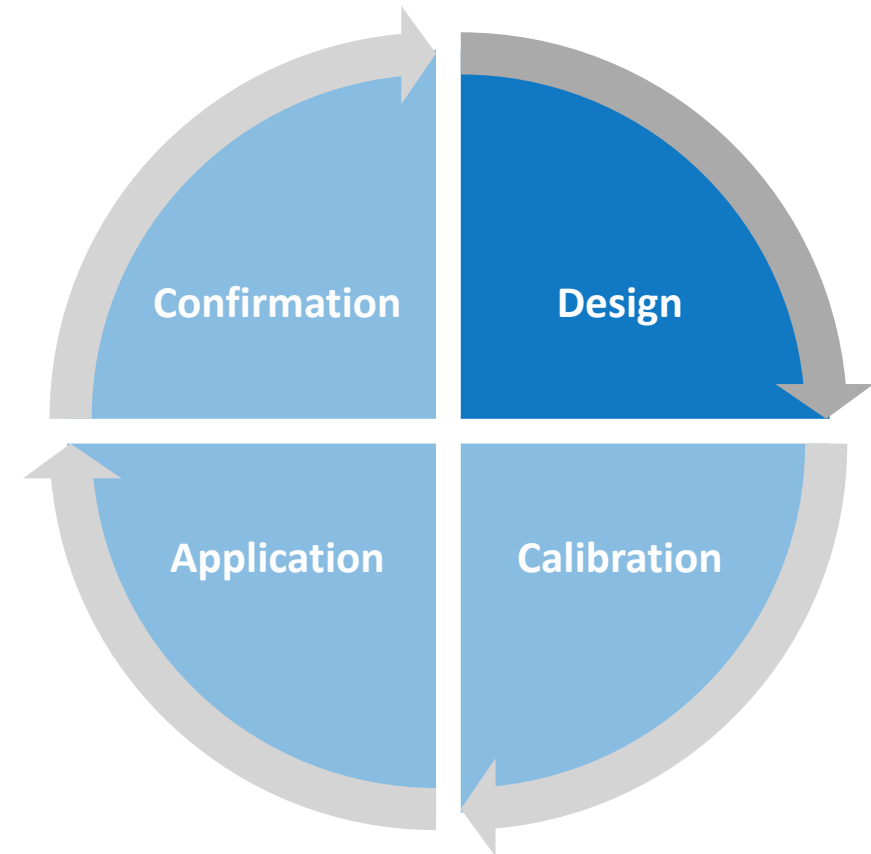
RRS is focused on understanding site goals and objectives

RRS plans for changes in the design that will best ensure that the goals and objectives are achieved.

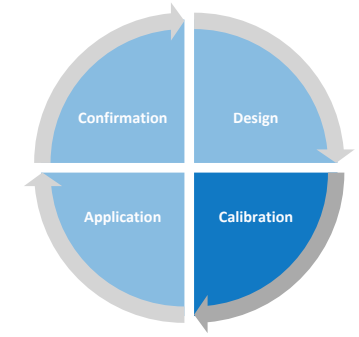
RRS correlates subsurface lithology, hydraulics, and design.

Comprehensive understanding of the reagents being applied, their chemistry, and distribution properties.

Detailed knowledge of design assumptions



Calibrate



Calibrate the design to match field conditions and injection-dose response

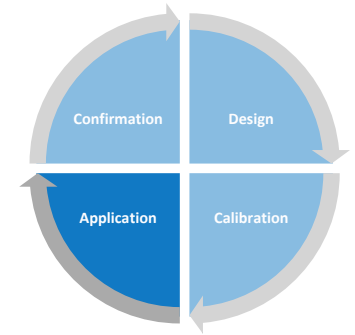
Observe and adjust for topographic variations and obstructions on-site

Initial injection points completed using placement validation process

- Piezometers
- Soil cores (pre and post injection)
- Geochemical signatures of amendments
- Synergistic real-time communication with project team



Application



**Application performed with high efficiency
using the safest operating procedures**

**State-of-the-art pressure and flow
transducers**

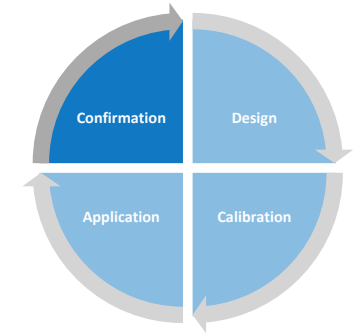
Provide high precision measurements

Real-time communication with project team

Quantitative observational reporting



Confirmation



“Trust but Verify”

Confirm the model throughout project

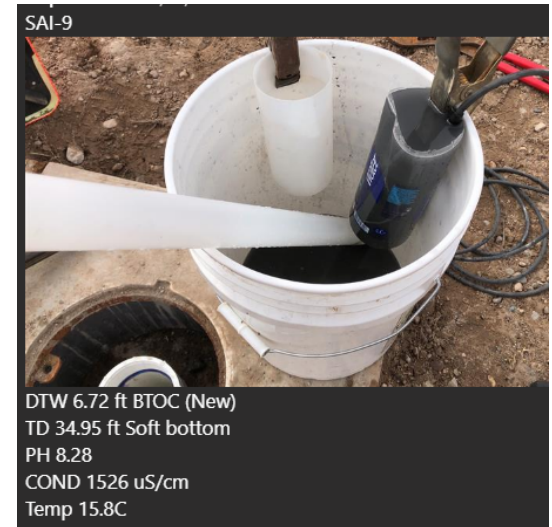
Adapt efficiently AND intelligently

Understand what drives the model

Understand the remedial amendments

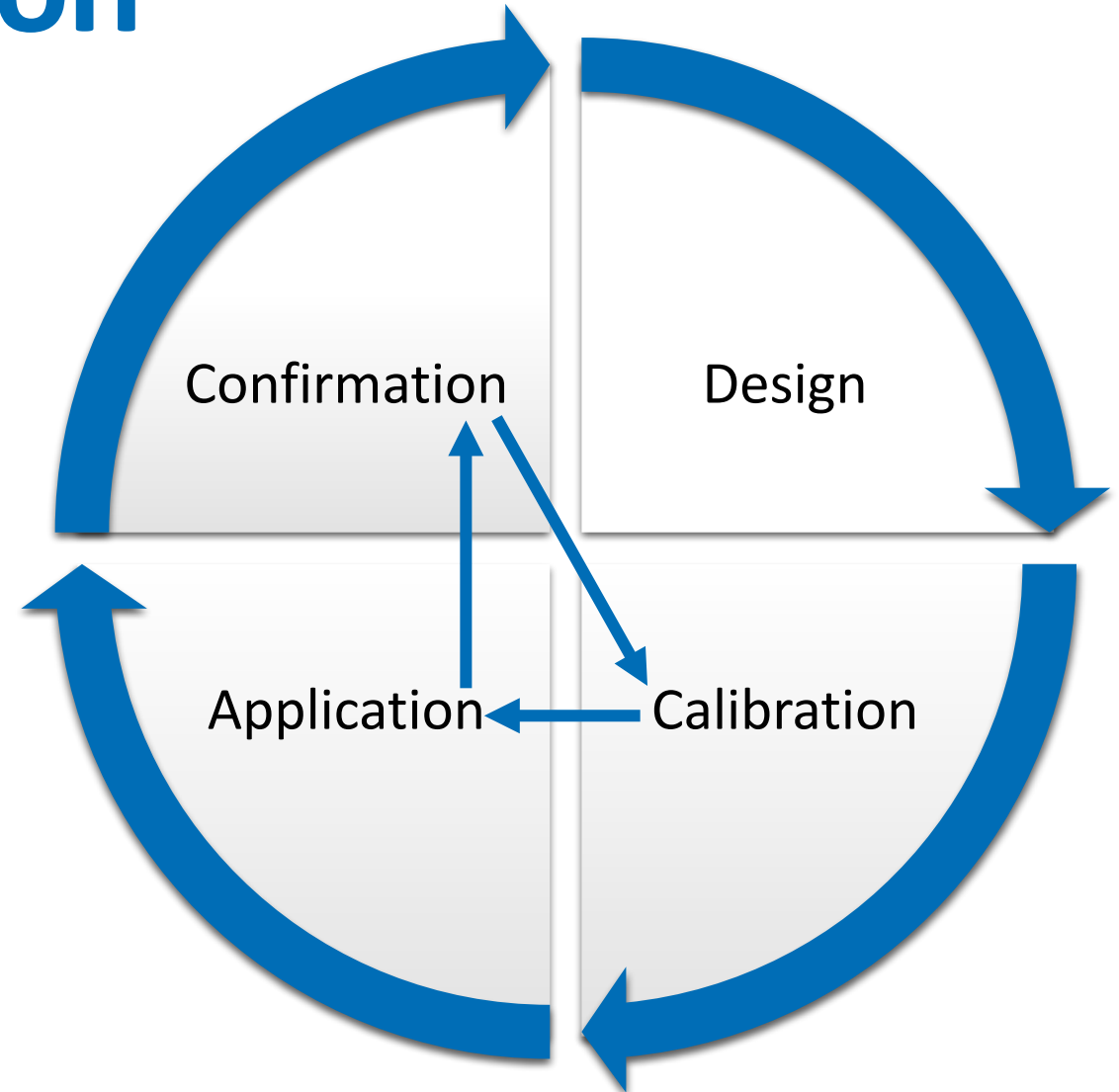
Observe and describe effects of hydraulic augmentation

Continued confirmation throughout application.



Dynamic Remediation

- 1. Design**
field ready remedial strategy
- 2. Calibrate**
assumptions vs field conditions and formation response
- 3. Application**
high efficiency using the safest operating procedures
- 4. Confirmation**
distribution through the target treatment zone



Challenges with Injection Projects

Initial design assumptions are only estimates

- Limited data density
- Significant assumptions as a result

Complex/difficult geology/hydro/COC transport

- High heterogeneity
- Multiple contaminant flux zones
- Commingled plumes

Budget/timeframe constraints

Project fast tracked to remedial action



Don't Panic!

There is a Wealth of Data Collected During Injections

Pressure

Flow rate

Volume

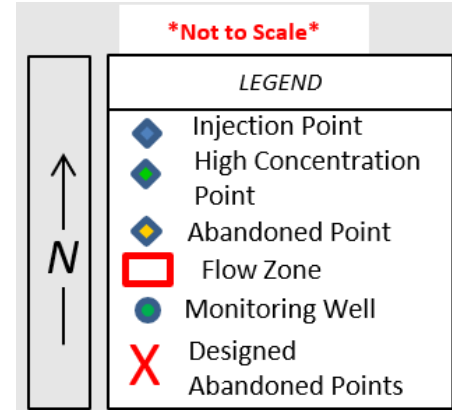
Depth

Point Spacing

Injection Point	Date	Time	Injection Depth (ft. bgs)	Injection Pressure (psi)	Flow Rate (gpm)	Volume of PlumeStop Injected		
						Beginning Flow Meter (gal.)	Ending Flow Meter (gal.)	Gallons Per Interval
B30			5-3			0.0		0.0
B31	7/2/2021	13:46	7-5	20	2.0	0.0	85.0	85.0
	7/2/2021	14:58	5-3	10	2.1	85.0	171.2	86.2
B32	7/7/2021	3:16	7-5	5	2.0	0.0	85.0	85.0
	7/7/2021	10:26	5-3	5	1.5	85.0	171.2	86.2
B33	7/8/2021	10:52	7-5	60	2.5	0.0	60.0	60.0
	7/8/2021	11:19	5-3	60	2.7	60.0	120.0	60.0
B34	7/7/2021	12:24	7-5	10	1.2	0.0	43.0	43.0
	7/7/2021	13:06	5-3	5	1.5	43.0	85.6	42.6
B35	7/2/2021	13:41	7-5	20	2.0	0.0	85.0	85.0
	7/2/2021	14:58	5-3	10	2.1	85.0	171.2	86.2
B36	7/7/2021	3:16	7-5	5	2.0	0.0	85.0	85.0
	7/7/2021	10:26	5-3	5	1.5	85.0	171.2	86.2
B37	7/8/2021	3:54	7-5	35	3.4	0.0	60.0	60.0
	7/8/2021	10:52	5-3	30	3.1	60.0	120.0	60.0
B38	7/7/2021	12:24	7-5	5	1.2	0.0	43.0	43.0

What do you typically do with it?

What can you do with it?



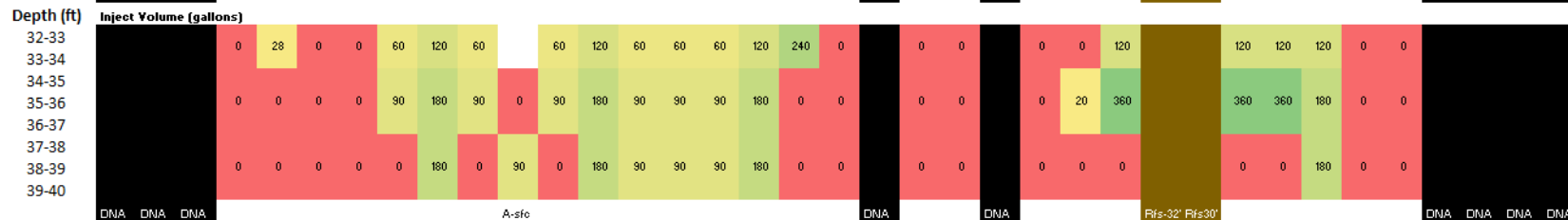
Pressure

Refusal before target depth



Flow

Points removed from PRB



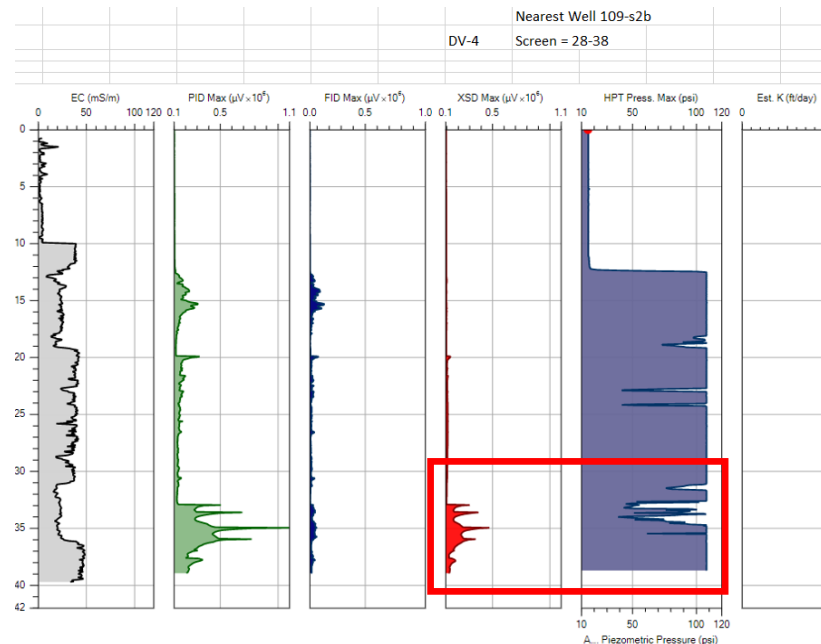
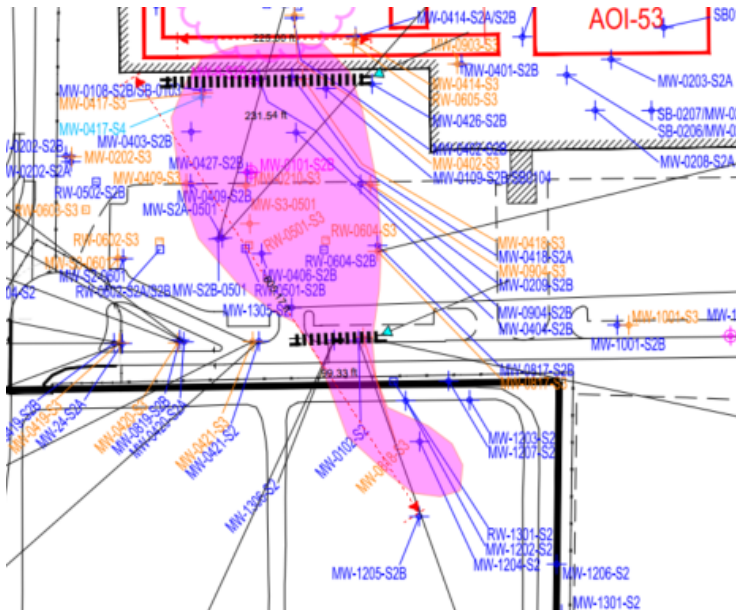
Volume

Site Background

CVOC site (Mostly PCE/TCE)

TTZ 32-40' bgs

PlumeStop barrier approach



DV-4

HPT >100 PSI except from about 32 to 37 ft bgs in this boring

Correlates with XSD (CVOC) detector hits.

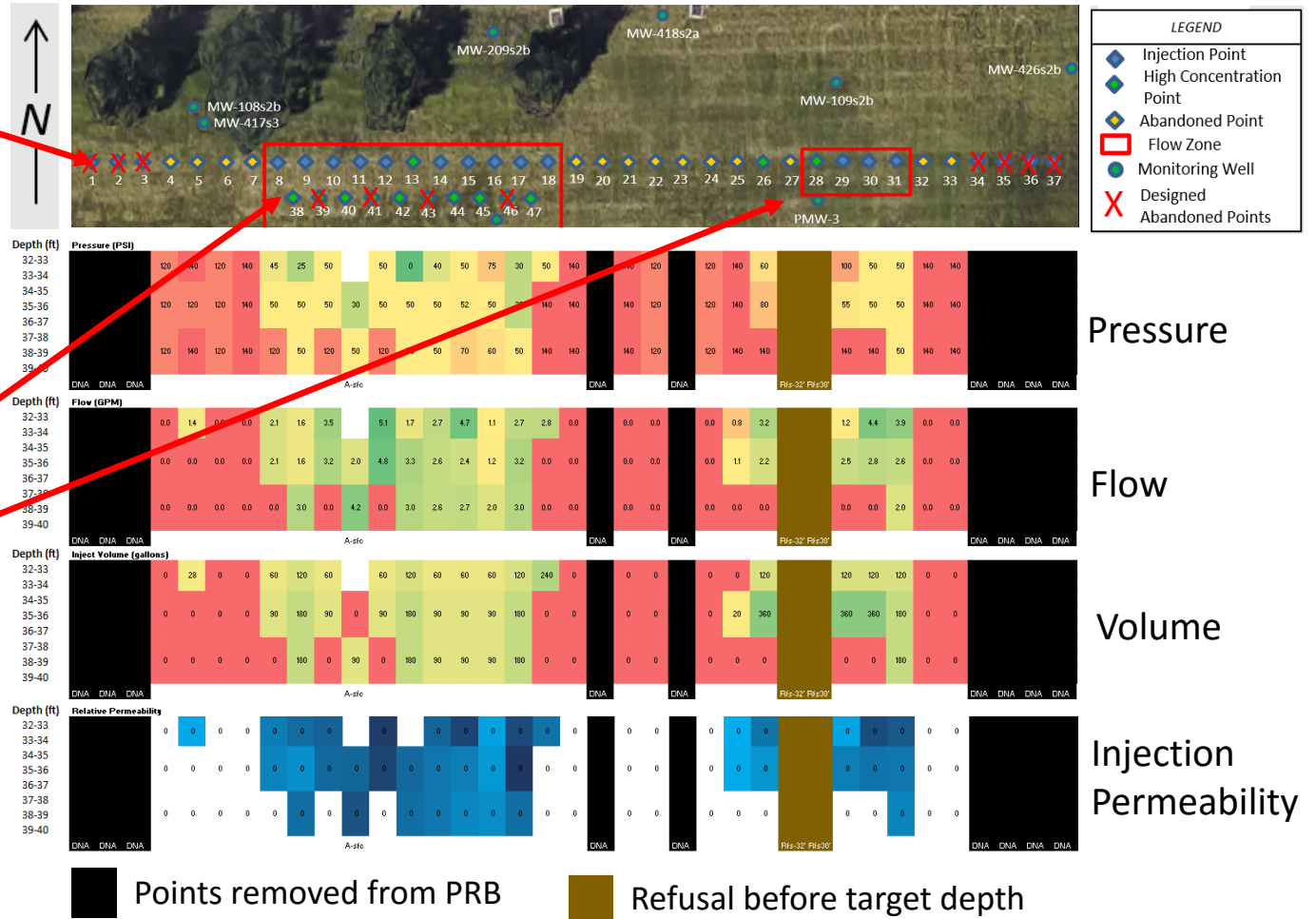
However, this zone is laterally discontinuous and completely disappears in some areas!!

Overcoming Challenges

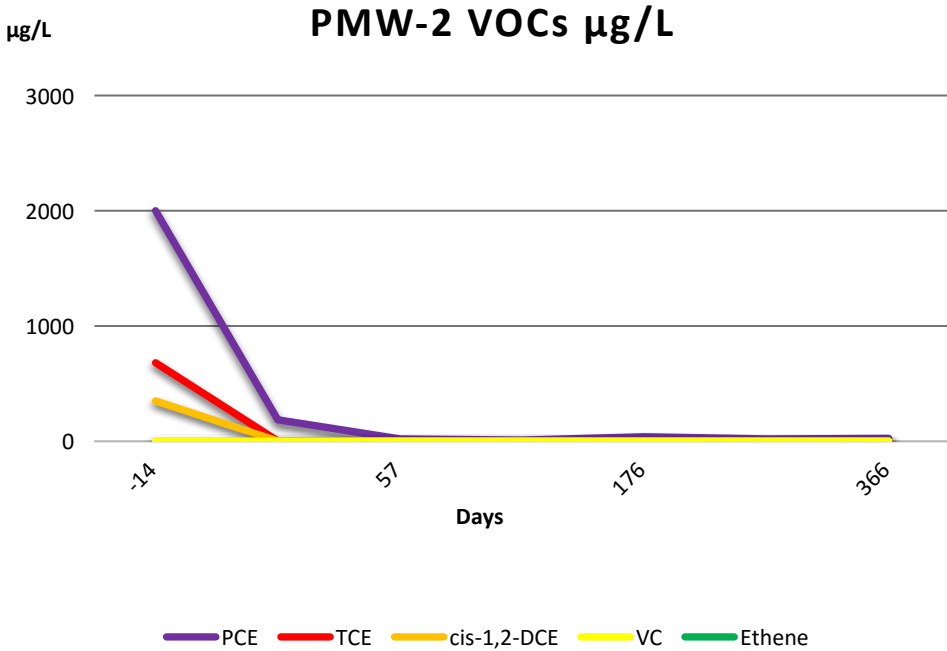
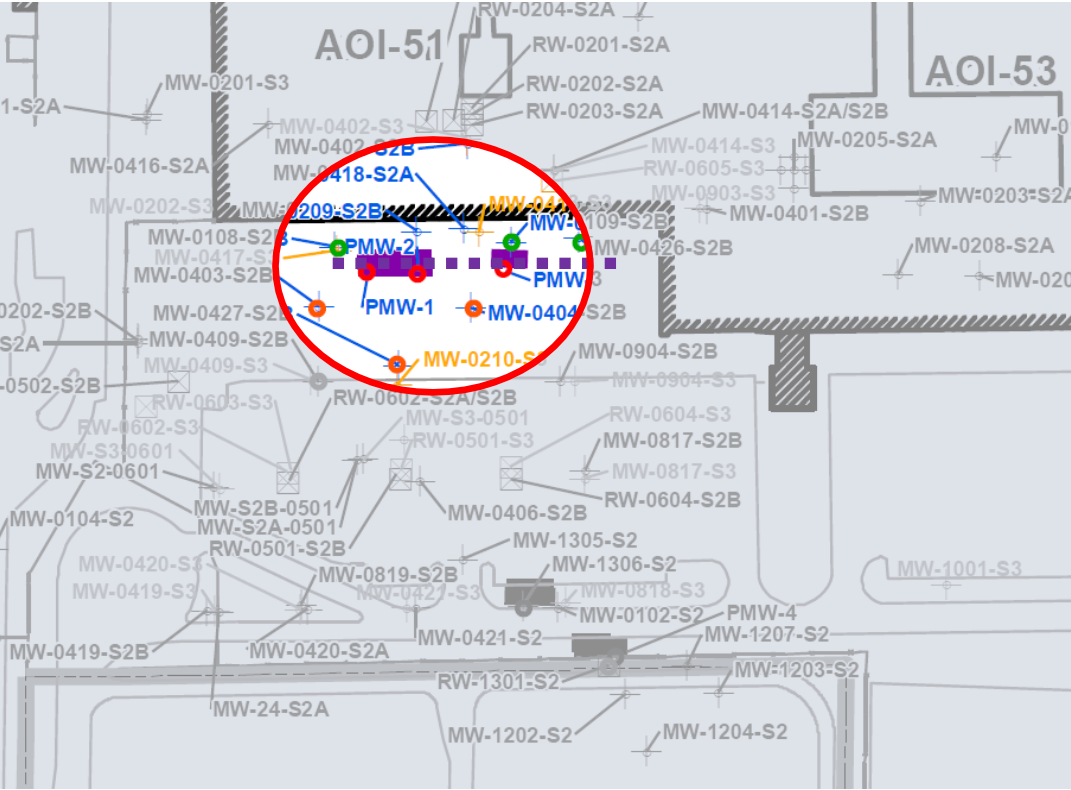
First pass in upper row.

Review data and visual mapping

Distribute volume from abandoned/refusal points to “high concentration” points in high permeability zones

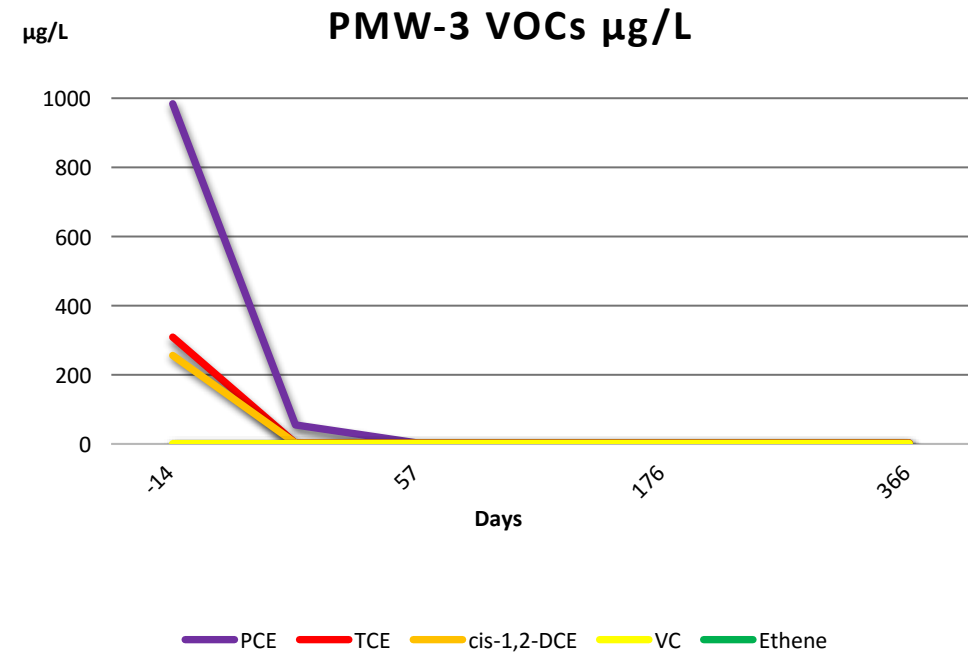
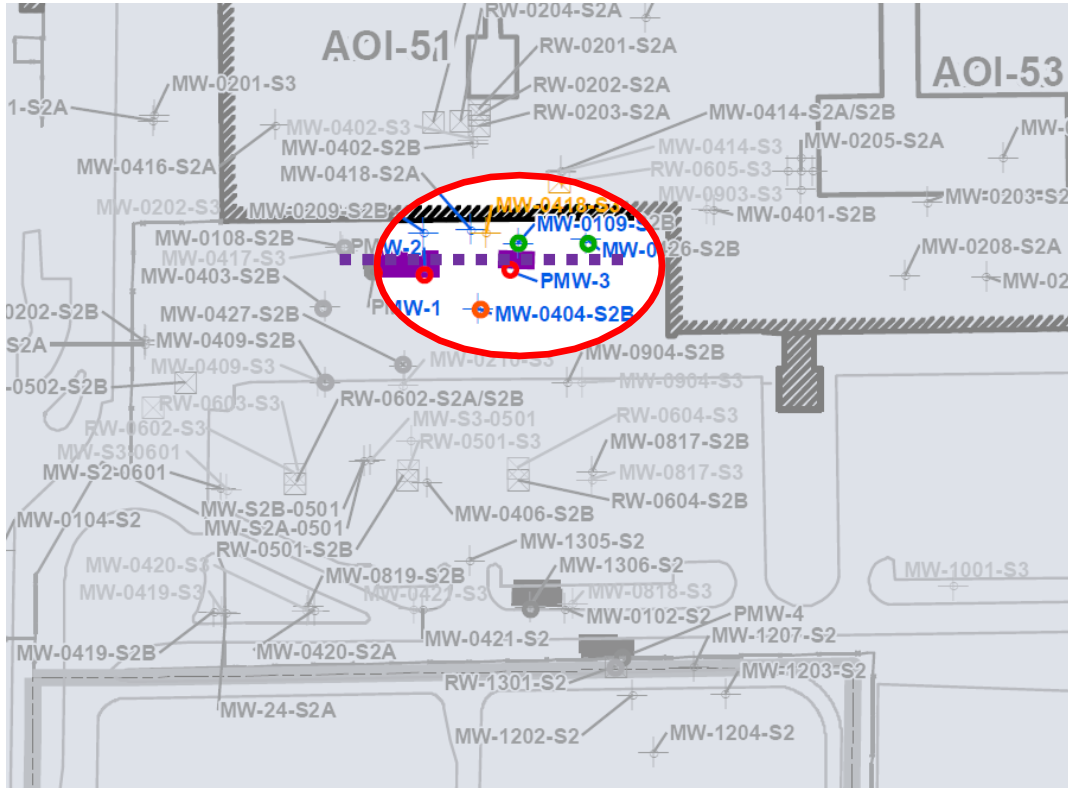


Results



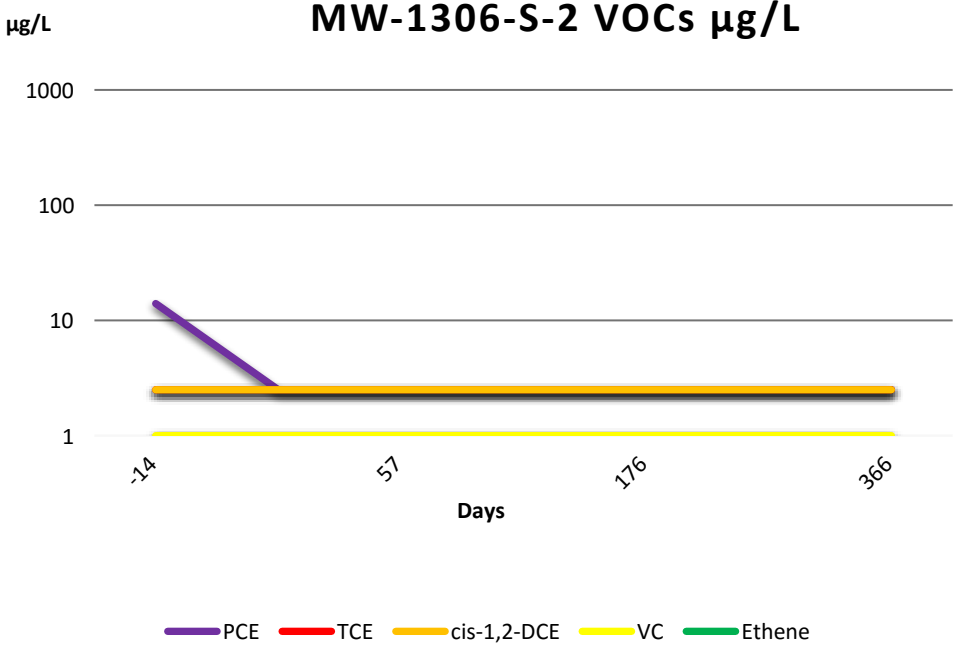
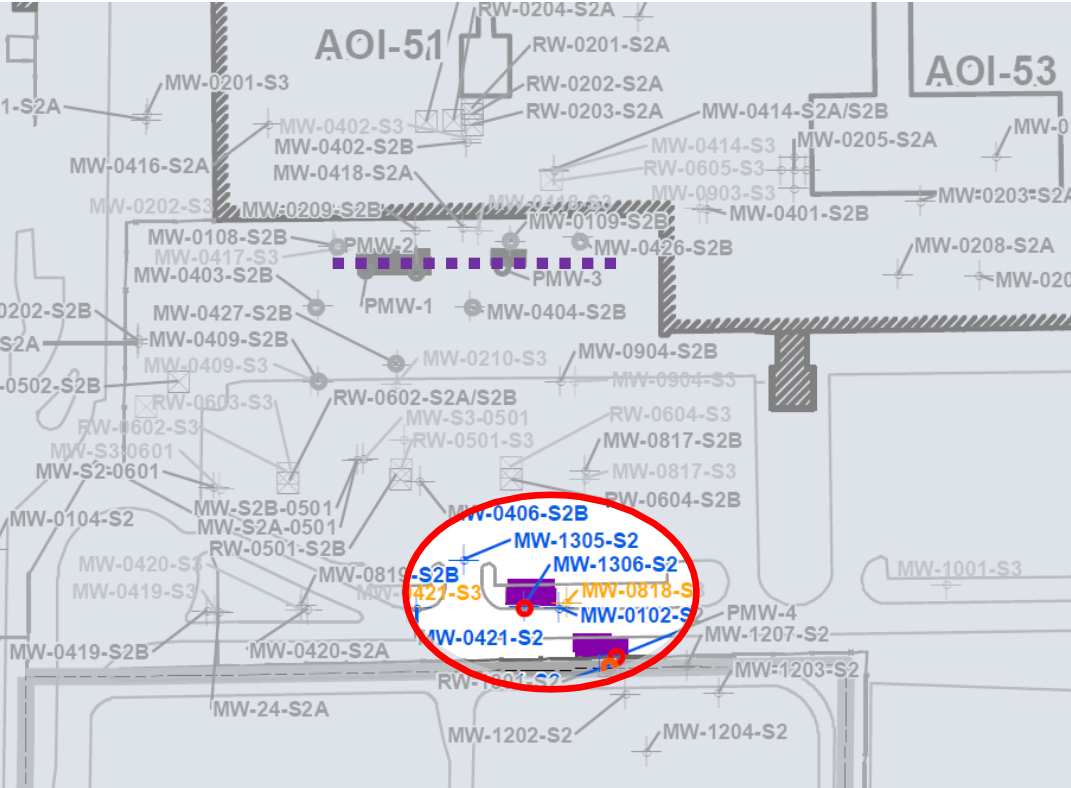
98% Reduction in Total VOC

Results



99.9% Reduction in Total VOC

Results



Reduced/Maintained Non-Detect

Summary

***In situ* injections are high density hydraulic characterization.**

(if done below fracture threshold)

The use of visual mapping of these data greatly improve technical decision making.

There is no additional cost! Anyone can do it!

Questions?