



Woodard
& Curran

May 11
2023

Groundwater Monitoring Efficiencies Using Modern Data Collection and Analysis Tools at a Site Transitioning to MNA

Battelle Bioremediation Symposium

Session: E8. Advances in Tools and Techniques for Assessing MNA

PRESENTED BY

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Technical Manager
Associate Principal

Physical Setting

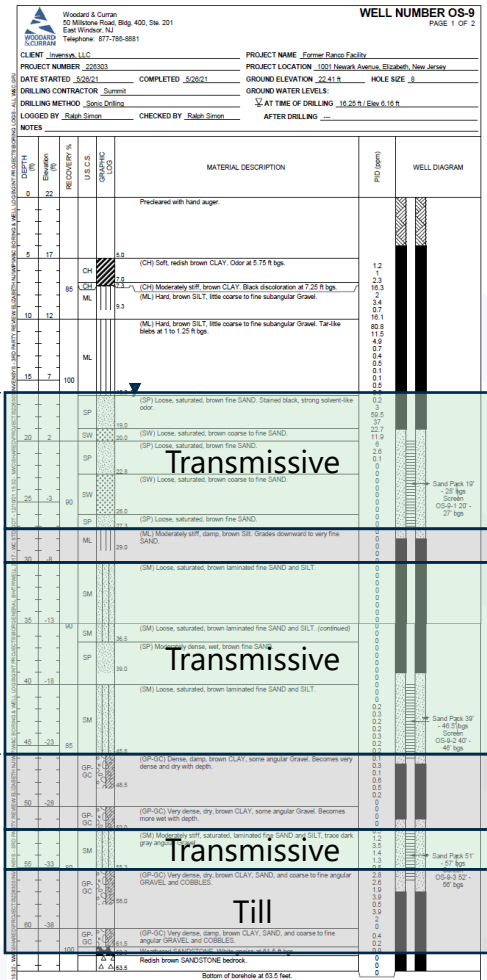


Buried Glacial Valley – Deltaic Sediments

Shallow Zone

Intermediate Zone

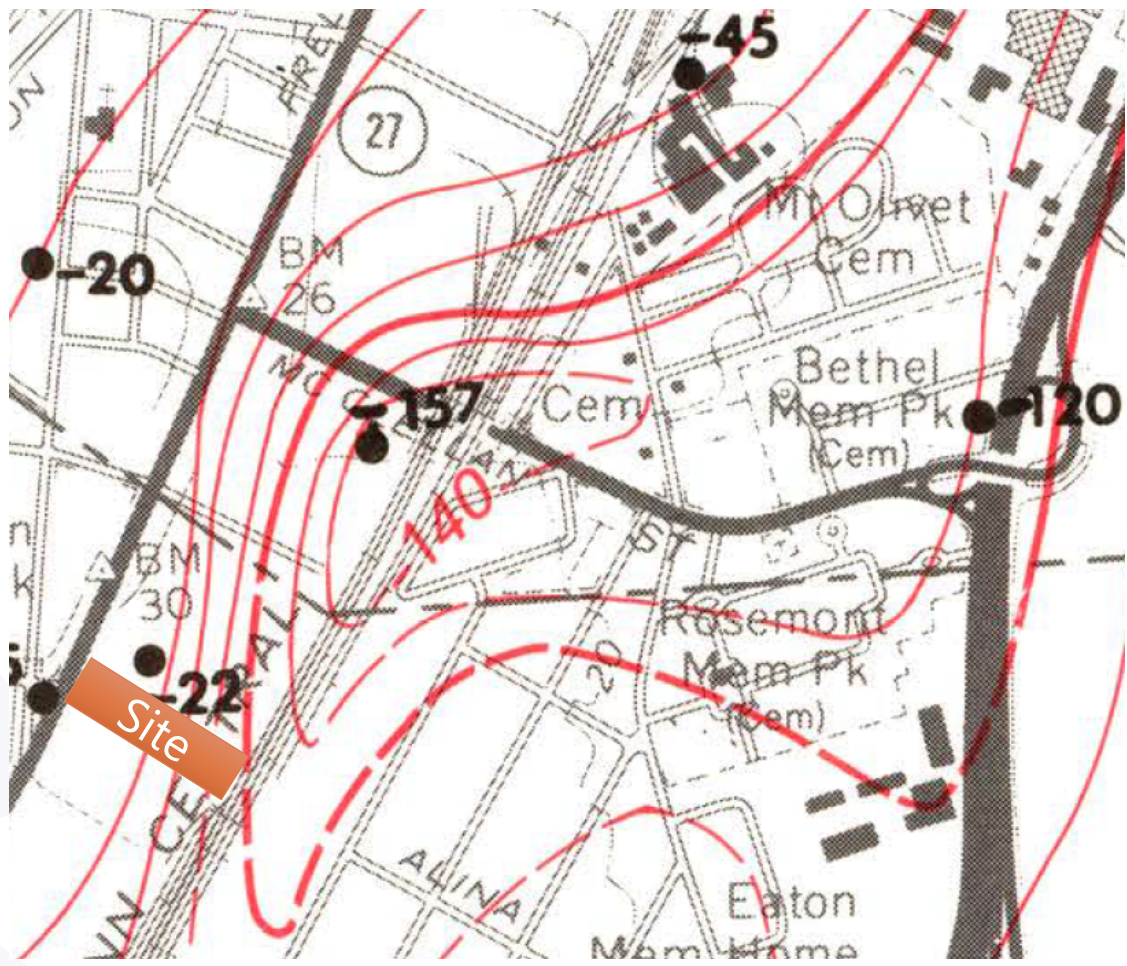
Deep Zone



WLE = 9.72 ft msl

WLE = 9.73 ft msl

WLE = 11.14 ft msl



Site History

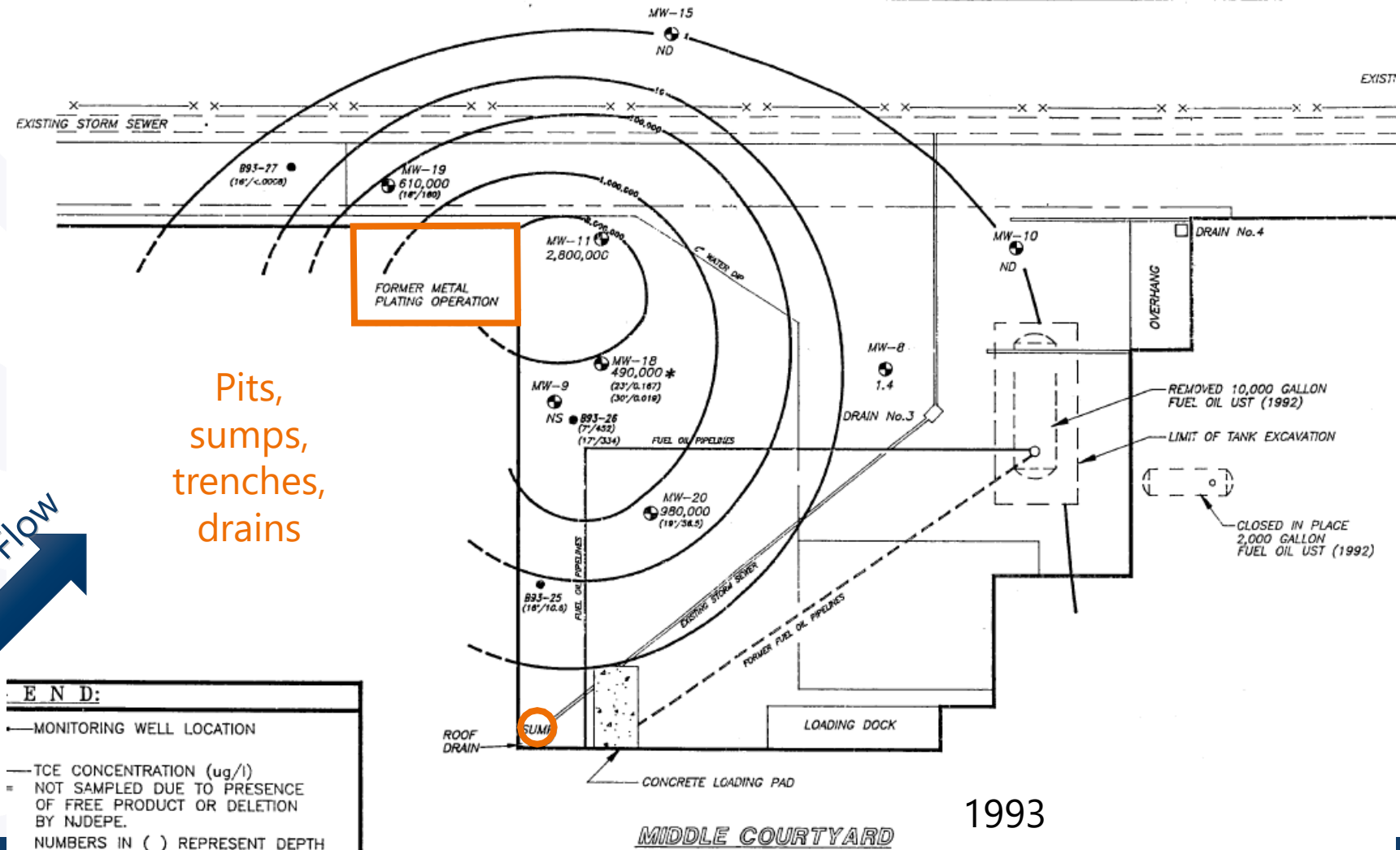
The background features a complex, abstract geometric pattern composed of overlapping, semi-transparent shapes in various shades of blue. These shapes include triangles, quadrilaterals, and irregular polygons, creating a layered, architectural effect. The pattern is most prominent on the right side of the slide, extending from the top right towards the bottom right. A thin, light blue line forms a rectangular frame around the text area on the left, with a small circle at the bottom right corner of the frame.

Historical Operations & TCE Concentrations

- Metal Plating
- Historical DNAPL at MW-11
- TCE = 2,800,000 ug/L



Pits,
sumps,
trenches,
drains



Remediation History

The background features a dark blue color with a complex, abstract pattern of overlapping, semi-transparent geometric shapes in a slightly lighter shade of blue. These shapes include various triangles, lines, and curved forms that create a sense of depth and movement. A thin, light green line is visible, forming a partial frame around the text area and extending towards the bottom right corner.

Thermal Remediation 2017-2018

- 19,900 lbs of VOCs removed
- Post-Remediation: TCE up to 4,630 ug/L (September 2019)
- Daughter products : 10,000 – 100,000 ug/L



June 2022: In-Situ Bioremediation / Chemical Reduction

→ Provect-IR

- ▶ Fermentable organic compounds + micro-scale ZVI

→ Approximately 50,000 pounds

→ 25% to 30% slurry



Current Conditions

The background features a dark blue field with several thick, wavy, light blue lines that create a sense of movement and depth. A light blue geometric shape, resembling a stylized mountain peak or a large 'A', is positioned in the upper right quadrant. A thin, light blue line forms a partial frame around the text, with a small circle at its bottom-right end.

Former Source Area Groundwater COCs Above GWQS - March 2023

Sample/Screen	Dup.	Date	Matrix	Parameter Group	Result Type	Parameter	Result txt.
DB-01 (51 - 61)	N	3/22/2023	GROUND WATER	VOCs	A	Trichloroethene	58.9
MW-9RD (30 - 35)	N	3/21/2023	GROUND WATER	VOCs	A	Trichloroethene	5.7
MW-35D (30 - 35)	Y	3/22/2023	GROUND WATER	VOCs	A	Trichloroethene	2.9
MW-35D (30 - 35)	N	3/22/2023	GROUND WATER	VOCs	A	Trichloroethene	2.6
MW-06 (15 - 30)	N	3/21/2023	GROUND WATER	VOCs	A	Trichloroethene	2.2
MW-06 (15 - 30)	Y	3/21/2023	GROUND WATER	VOCs	A	Trichloroethene	1.8

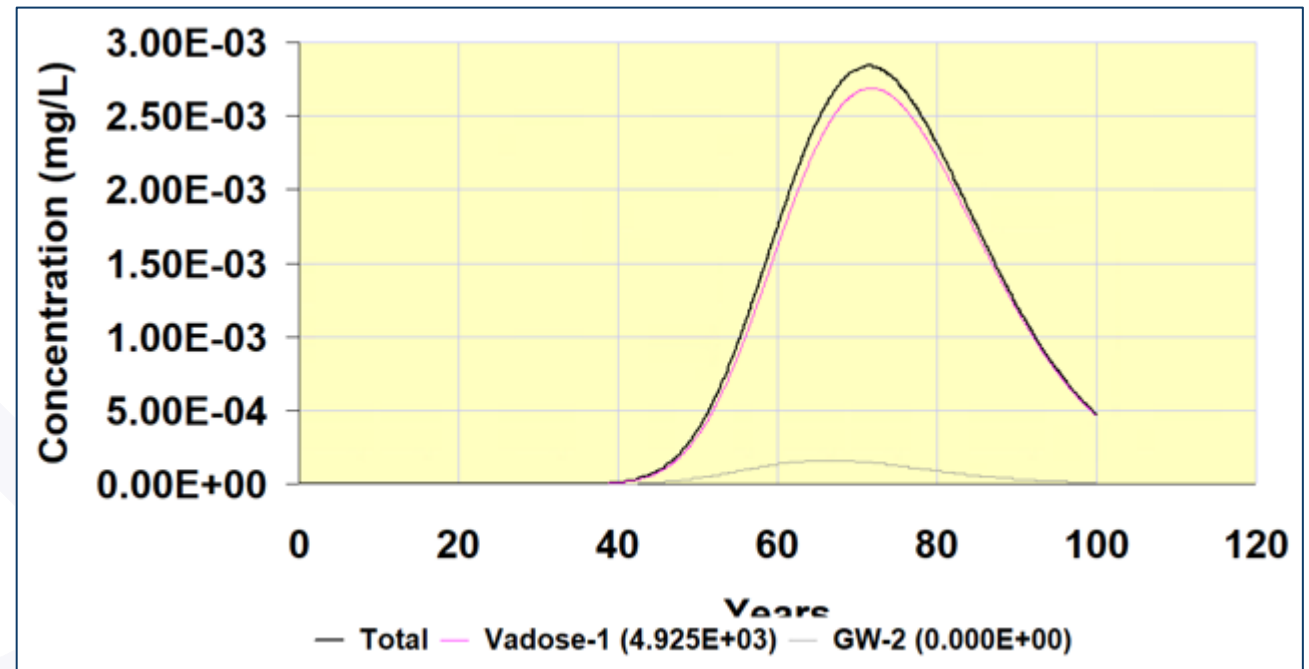
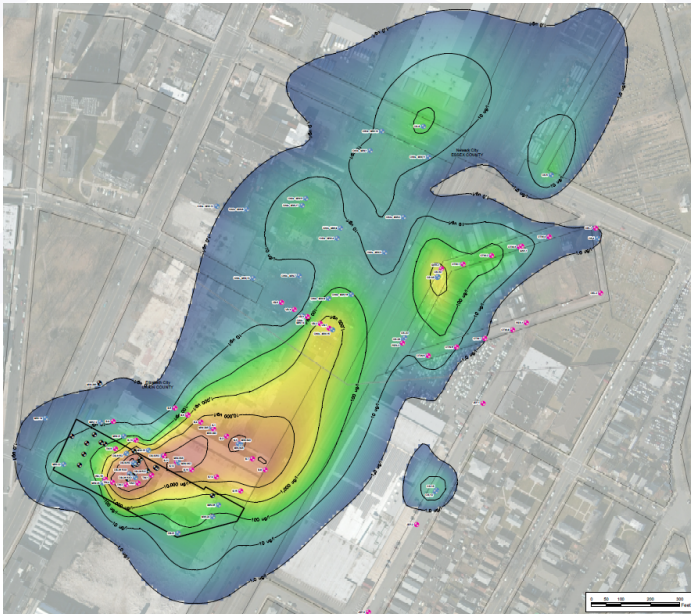
Sample/Screen	Dup.	Date	Matrix	Parameter Group	Result Type	Parameter	Result txt.
MW-19 (15 - 20)	N	3/22/2023	GROUND WATER	VOCs	A	cis-1,2-Dichloroethene	113000
MW-9RD (30 - 35)	N	3/21/2023	GROUND WATER	VOCs	A	cis-1,2-Dichloroethene	2070
MW-06 (15 - 30)	N	3/21/2023	GROUND WATER	VOCs	A	cis-1,2-Dichloroethene	556
MW-06 (15 - 30)	Y	3/21/2023	GROUND WATER	VOCs	A	cis-1,2-Dichloroethene	529
MW-35D (30 - 35)	N	3/22/2023	GROUND WATER	VOCs	A	cis-1,2-Dichloroethene	192
MW-35D (30 - 35)	Y	3/22/2023	GROUND WATER	VOCs	A	cis-1,2-Dichloroethene	184

Sample/Screen	Dup.	Date	Matrix	Parameter Group	Result Type	Parameter	Result txt.
MW-19 (15 - 20)	N	3/22/2023	GROUND WATER	VOCs	A	Vinyl chloride	22200
MW-36D (27 - 32)	N	3/22/2023	GROUND WATER	VOCs	A	Vinyl chloride	4260
MW-9RD (30 - 35)	N	3/21/2023	GROUND WATER	VOCs	A	Vinyl chloride	2250
MW-06 (15 - 30)	N	3/21/2023	GROUND WATER	VOCs	A	Vinyl chloride	863
MW-06 (15 - 30)	Y	3/21/2023	GROUND WATER	VOCs	A	Vinyl chloride	777
MW-35D (30 - 35)	Y	3/22/2023	GROUND WATER	VOCs	A	Vinyl chloride	517
MW-35D (30 - 35)	N	3/22/2023	GROUND WATER	VOCs	A	Vinyl chloride	490
MW-24 (10 - 25)	N	3/21/2023	GROUND WATER	VOCs	A	Vinyl chloride	13
MW-25R (30 - 35)	N	3/22/2023	GROUND WATER	VOCs	A	Vinyl chloride	6.9
MW-35S (15 - 20)	N	3/21/2023	GROUND WATER	VOCs	A	Vinyl chloride	1.6

Long-Term Remedial Approach

Monitored Natural Attenuation

→ Potential monitoring for 100 years



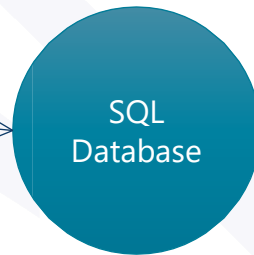
Data Collection & Analytics Tools

Building a Data Ecosystem

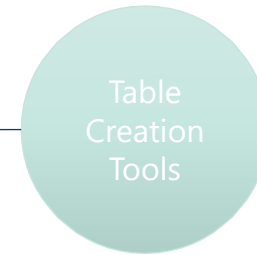
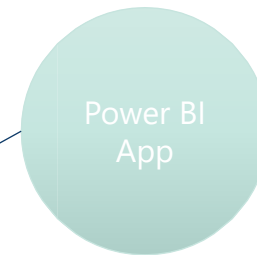
Data Collection



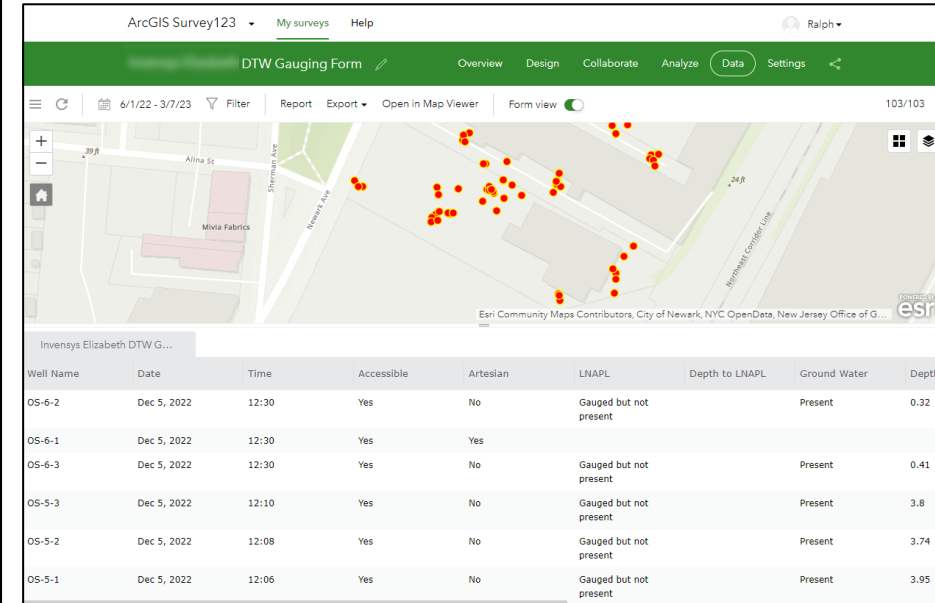
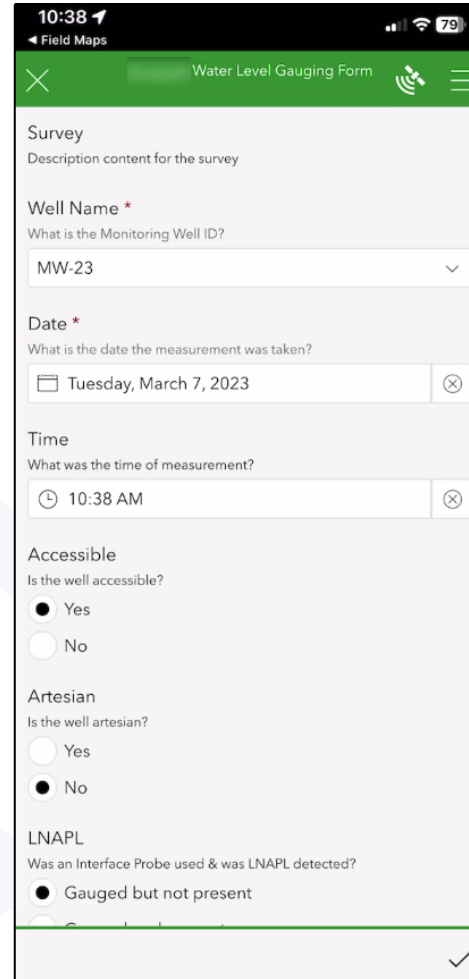
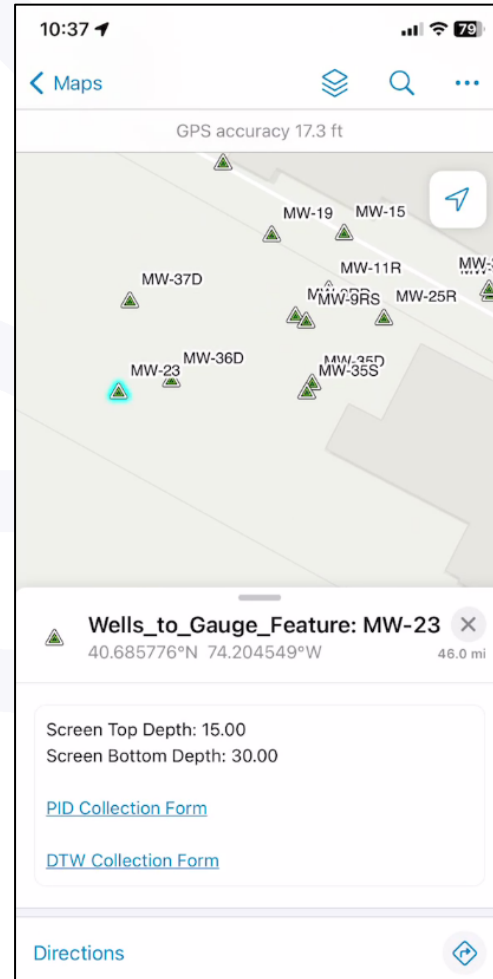
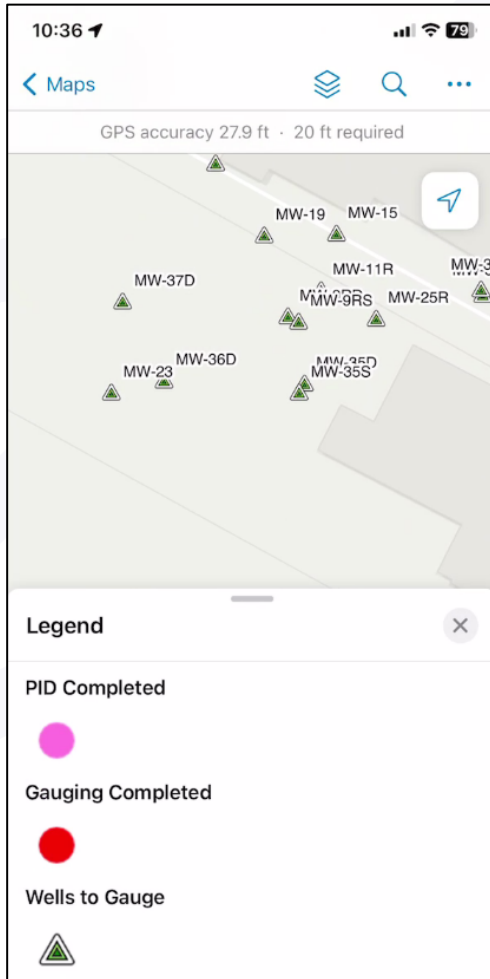
Data Storage



Analysis / Reporting

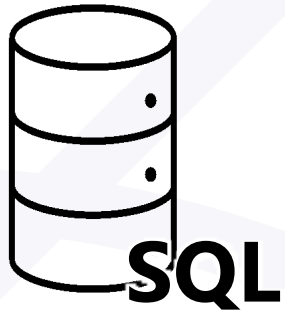


Data Collection: ESRI Field Maps + Survey123



Improvement
Reduce lost time
Improve data quality
Save 2-3 hour summarizing data

Data Storage: SQL Database



- Coordinates
- Construction
- Samples
- Results
- Standards
- Groundwater Gauging
- Low Flow Groundwater Parameters

Improvement

Improve data quality

Enable advanced data collection/reporting tools

Save ~4 hrs data management

Analysis / Reporting: Power BI

Power BI DART Portal Welcome Page

File Share Export Chat in Teams Get insights Subscribe to report

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Welcome to the DART Portal

Navigation

- Use the navigation buttons to the left to navigate the portal.
- The navigation pane may be closed by clicking the left arrows near the top of the screen.
- If viewing in Teams, you can create multiple copies of the portal by clicking the down arrow next to the DART Portal tab and clicking "Pop out tab".

Contents

- Review Data Section - provides access to project data
 - Investigation Summary Dashboard - provides summaries of sampling locations, well construction, and analytical results
 - GW Trends - performs Mann-Kendall analysis of groundwater concentration trends summarized multiple ways
- Review Standards - provides access to regulatory standards
- Contact DART - links to forms where you can let us know about issues with the portal, request support, let us know what you think, provide suggestions, and get information about adding your project to DART.

Projects Served

The projects listed below are currently served through DART, to add your project data, [contact us!](#)

Mann-Kendall Summary of Results

Site / Area Name	Parameter Class. Analysis Type Well	VOCs A		
		cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
	DB-01 (51 - 61)	Stable	Decreasing	ND
	DB-30RX1 (65 - 70)	ND	Decreasing	ND
	DB-30RX2 (95 - 100)	ND	Decreasing	ND
	DB-30RX3 (110 - 115)	ND	Decreasing	ND
	DB-30RX4 (130 - 135)	ND	Decreasing	ND
	DB-31RX1 (57 - 67)	Decreasing	No Trend	ND
	DB-31RX2 (73 - 78)	ND	Stable	ND
	DB-31RX3 (102 - 107)	ND	Decreasing	ND
	DB-31RX4 (130 - 135)	No Trend	No Trend	ND
	MW-06 (15 - 30)	Decreasing	Decreasing	Decreasing
	MW-11R (10 - 15)	Decreasing	Decreasing	Decreasing
	MW-19 (15 - 20)	Potentially Decreasing	Decreasing	No Trend
	MW-22 (30 - 40)	ND	ND	ND
	MW-23 (15 - 30)	NS	NS	NS
	MW-24 (10 - 25)	Decreasing	Decreasing	Stable
	MW-25R (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35D (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35S (15 - 20)	Decreasing	Decreasing	No Trend
	MW-36D (27 - 32)	Decreasing	ND	Decreasing
	MW-37D (25 - 30)	NS	NS	NS
	MW-9RD (30 - 35)	No Trend	Decreasing	No Trend
	MW-9RS (20 - 25)	Decreasing	ND	No Trend

Mann-Kendall Summary of Results

→ Not enough data for determination

Site / Area Name	Parameter Class. Analysis Type Well	VOCs A		
		cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
	DB-01 (51 - 61)	Stable	Decreasing	ND
	DB-30RX1 (65 - 70)	ND	Decreasing	ND
	DB-30RX2 (95 - 100)	ND	Decreasing	ND
	DB-30RX3 (110 - 115)	ND	Decreasing	ND
	DB-30RX4 (130 - 135)	ND	Decreasing	ND
	DB-31RX1 (57 - 67)	Decreasing	No Trend	ND
	DB-31RX2 (73 - 78)	ND	Stable	ND
	DB-31RX3 (102 - 107)	ND	Decreasing	ND
	DB-31RX4 (130 - 135)	No Trend	No Trend	ND
	MW-06 (15 - 30)	Decreasing	Decreasing	Decreasing
	MW-11R (10 - 15)	Decreasing	Decreasing	Decreasing
	MW-19 (15 - 20)	Potentially Decreasing	Decreasing	No Trend
	MW-22 (30 - 40)	ND	ND	ND
	MW-23 (15 - 30)	NS	NS	NS
	MW-24 (10 - 25)	Decreasing	Decreasing	Stable
	MW-25R (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35D (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35S (15 - 20)	Decreasing	Decreasing	No Trend
	MW-36D (27 - 32)	Decreasing	ND	Decreasing
	MW-37D (25 - 30)	NS	NS	NS
	MW-9RD (30 - 35)	No Trend	Decreasing	No Trend
	MW-9RS (20 - 25)	Decreasing	ND	No Trend

Mann-Kendall Summary of Results

→ Several success stories

- decreased to below standard

Site / Area Name	Parameter Class. Analysis Type Well	VOCs A		
		cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
	DB-01 (51 - 61)	Stable	Decreasing	ND
	DB-30RX1 (65 - 70)	ND	Decreasing	ND
	DB-30RX2 (95 - 100)	ND	Decreasing	ND
	DB-30RX3 (110 - 115)	ND	Decreasing	ND
	DB-30RX4 (130 - 135)	ND	Decreasing	ND
	DB-31RX1 (57 - 67)	Decreasing	No Trend	ND
	DB-31RX2 (73 - 78)	ND	Stable	ND
	DB-31RX3 (102 - 107)	ND	Decreasing	ND
	DB-31RX4 (130 - 135)	No Trend	No Trend	ND
	MW-06 (15 - 30)	Decreasing	Decreasing	Decreasing
	MW-11R (10 - 15)	Decreasing	Decreasing	Decreasing
	MW-19 (15 - 20)	Potentially Decreasing	Decreasing	No Trend
	MW-22 (30 - 40)	ND	ND	ND
	MW-23 (15 - 30)	NS	NS	NS
	MW-24 (10 - 25)	Decreasing	Decreasing	Stable
	MW-25R (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35D (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35S (15 - 20)	Decreasing	Decreasing	No Trend
	MW-36D (27 - 32)	Decreasing	ND	Decreasing
	MW-37D (25 - 30)	NS	NS	NS
	MW-9RD (30 - 35)	No Trend	Decreasing	No Trend
	MW-9RS (20 - 25)	Decreasing	ND	No Trend

MW-11R

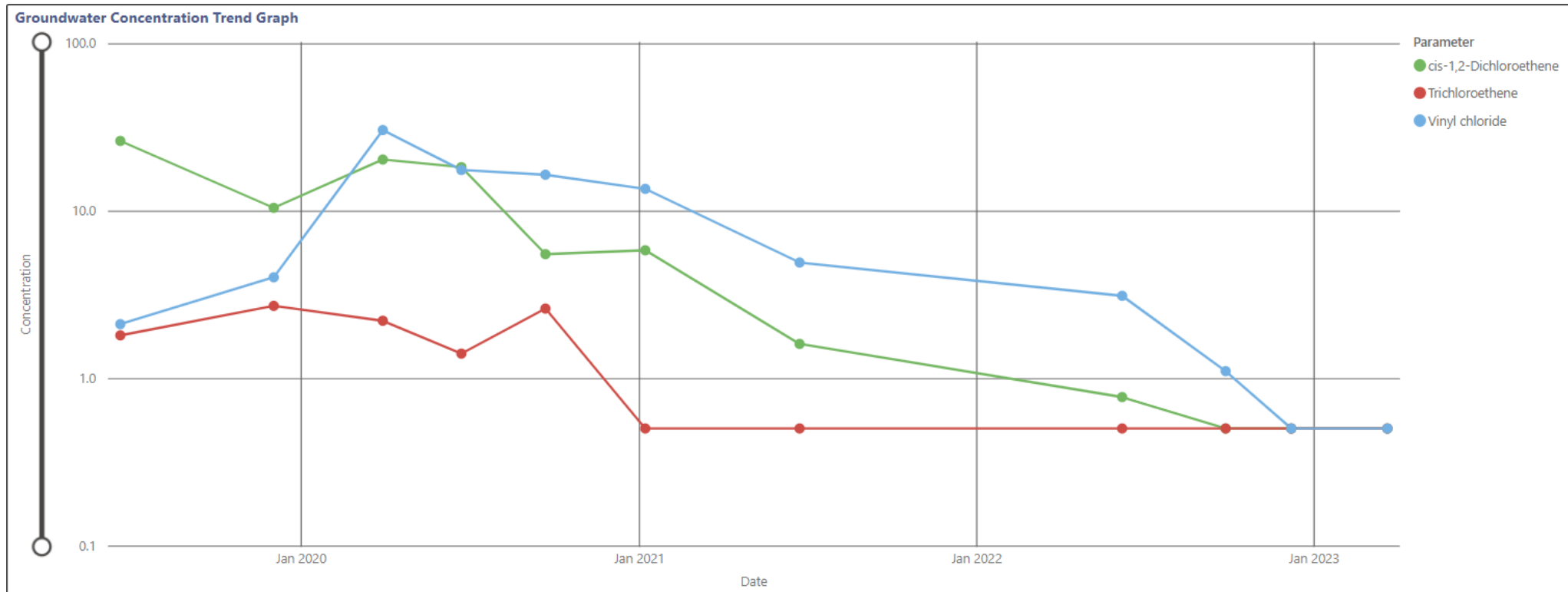
←

Parameter Group	Parameter	Location Tp., Well Tp., Abandon...	Parameter	MK Result	S	COV	# of Detections	P	Stan. Dev.
All	Multiple selections	All	cis-1,2-Dichloroethene	Decreasing	-45	1.16	8	1.00	12.85
			Trichloroethene	Decreasing	-30	0.76	5	0.99	12.85
			Vinyl chloride	Decreasing	-26	0.97	9	0.97	12.85
			Ethane	No Trend	36	1.71	5	1.00	12.85
			Ethene	No Trend	19	0.90	6	0.92	12.85
			Filtered Iron	No Trend	32	0.87	10	1.00	11.18

Result Type: All

Site/Area: 1001 Newark Ave.

Sample/Screen: MW-11R (10 - 15)



Mann-Kendall Summary of Results

→ Several success stories

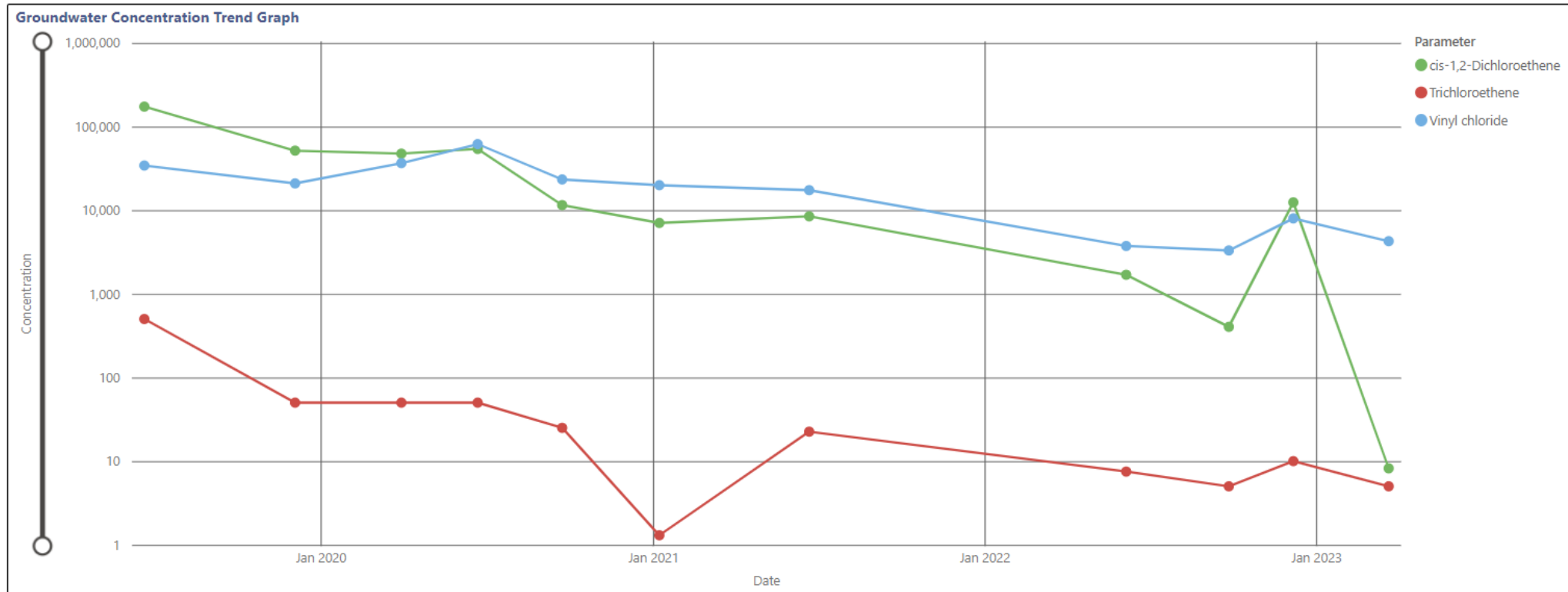
- ND, or decreasing, or stable

Site / Area Name	Parameter Class. Analysis Type Well	VOCs A		
		cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
DB-01 (51 - 61)	Stable	Decreasing	ND	ND
DB-30RX1 (65 - 70)	ND	Decreasing	ND	ND
DB-30RX2 (95 - 100)	ND	Decreasing	ND	ND
DB-30RX3 (110 - 115)	ND	Decreasing	ND	ND
DB-30RX4 (130 - 135)	ND	Decreasing	ND	ND
DB-31RX1 (57 - 67)	Decreasing	No Trend	ND	ND
DB-31RX2 (73 - 78)	ND	Stable	ND	ND
DB-31RX3 (102 - 107)	ND	Decreasing	ND	ND
DB-31RX4 (130 - 135)	No Trend	No Trend	ND	ND
MW-06 (15 - 30)	Decreasing	Decreasing	Decreasing	Decreasing
MW-11R (10 - 15)	Decreasing	Decreasing	Decreasing	Decreasing
MW-19 (15 - 20)	Potentially Decreasing	Decreasing	No Trend	No Trend
MW-22 (30 - 40)	ND	ND	ND	ND
MW-23 (15 - 30)	NS	NS	NS	NS
MW-24 (10 - 25)	Decreasing	Decreasing	Stable	Stable
MW-25R (30 - 35)	Decreasing	Decreasing	No Trend	No Trend
MW-35D (30 - 35)	Decreasing	Decreasing	No Trend	No Trend
MW-35S (15 - 20)	Decreasing	Decreasing	No Trend	No Trend
MW-36D (27 - 32)	Decreasing	ND	Decreasing	Decreasing
MW-37D (25 - 30)	NS	NS	NS	NS
MW-9RD (30 - 35)	No Trend	Decreasing	No Trend	No Trend
MW-9RS (20 - 25)	Decreasing	ND	No Trend	No Trend

MW-36D

→ All decreasing or ND

Parameter Group	Parameter	Location Tp., Well Tp., Abandon...	Parameter	MK Result	S	COV	# of Detections	P	Stan. Dev.
All	Multiple selections	All	cis-1,2-Dichloroethene	Decreasing	-45	1.24	11	1.00	12.85
			Vinyl chloride	Decreasing	-29	0.72	11	0.99	12.85
			Trichloroethene	ND	-33	1.83	1	0.99	12.85
			Ethane	No Trend	32	1.27	11	0.99	12.85
			Ethene	No Trend	19	0.60	11	0.92	12.85
			Filtered Iron	No Trend	22	1.40	8	0.97	11.18



Mann-Kendall Summary of Results

→ Other information may support MNA

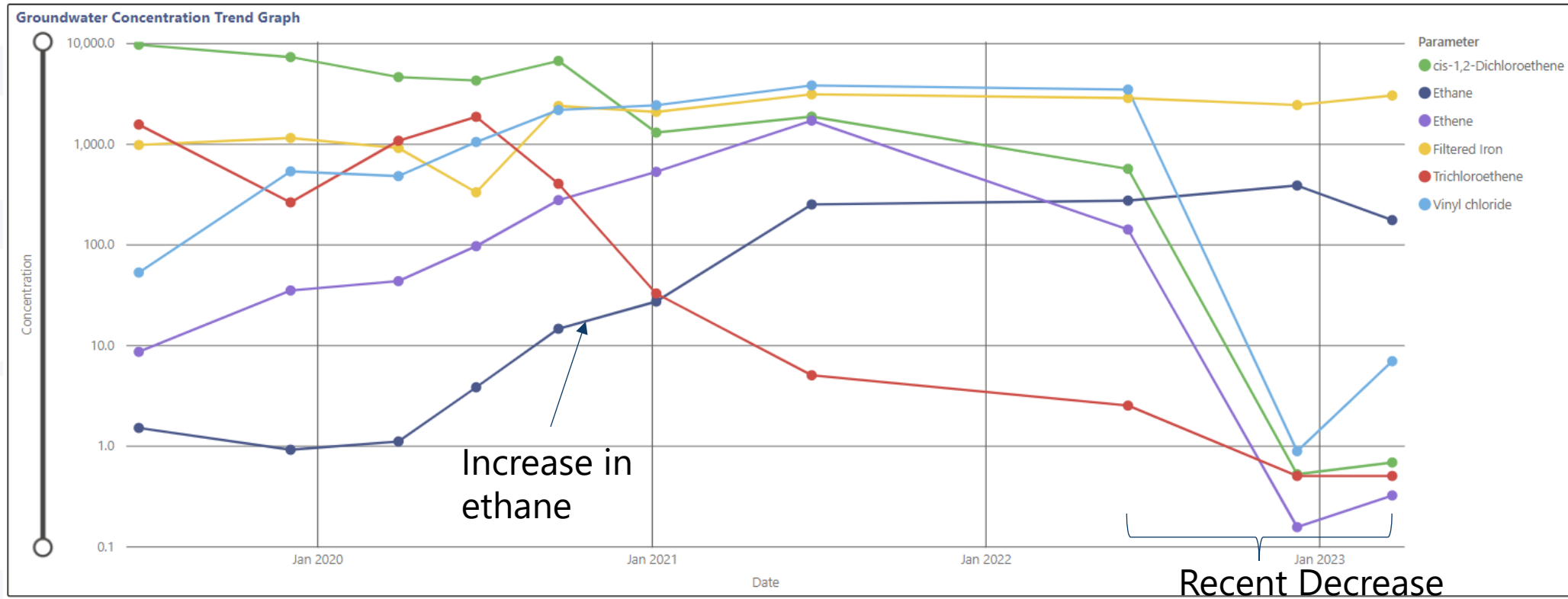
Site / Area Name	Parameter Class. Analysis Type Well	VOCs A		
		cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
	DB-01 (51 - 61)	Stable	Decreasing	ND
	DB-30RX1 (65 - 70)	ND	Decreasing	ND
	DB-30RX2 (95 - 100)	ND	Decreasing	ND
	DB-30RX3 (110 - 115)	ND	Decreasing	ND
	DB-30RX4 (130 - 135)	ND	Decreasing	ND
	DB-31RX1 (57 - 67)	Decreasing	No Trend	ND
	DB-31RX2 (73 - 78)	ND	Stable	ND
	DB-31RX3 (102 - 107)	ND	Decreasing	ND
	DB-31RX4 (130 - 135)	No Trend	No Trend	ND
	MW-06 (15 - 30)	Decreasing	Decreasing	Decreasing
	MW-11R (10 - 15)	Decreasing	Decreasing	Decreasing
	MW-19 (15 - 20)	Potentially Decreasing	Decreasing	No Trend
	MW-22 (30 - 40)	ND	ND	ND
	MW-23 (15 - 30)	NS	NS	NS
	MW-24 (10 - 25)	Decreasing	Decreasing	Stable
	MW-25R (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35D (30 - 35)	Decreasing	Decreasing	No Trend
	MW-35S (15 - 20)	Decreasing	Decreasing	No Trend
	MW-36D (27 - 32)	Decreasing	ND	Decreasing
	MW-37D (25 - 30)	NS	NS	NS
	MW-9RD (30 - 35)	No Trend	Decreasing	No Trend
	MW-9RS (20 - 25)	Decreasing	ND	No Trend

MW-25R

Parameter Group:
 Parameter:
 Location Tp.:
 Well Tp.:

Result Type:
 Site/Area:
 Sample/Screen:

Parameter	MK Result	S	COV	# of Detections	P	Stan. Dev.
cis-1,2-Dichloroethene	Decreasing	-39	1.00	10	1.00	11.18
Trichloroethene	Decreasing	-32	1.37	6	1.00	11.18
Ethane	No Trend	39	1.41	10	1.00	11.18
Ethene	No Trend	5	1.51	9	0.64	11.18
Filtered Iron	No Trend	23	0.51	10	0.98	11.18
Vinyl chloride	No Trend	3	0.92	10	0.57	11.18



Mann-Kendall Summary of Results

→ Locations that need to be watched

Site / Area Name	Parameter Class. Analysis Type Well	VOCs A		
		cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
DB-01 (51 - 61)		Stable	Decreasing	ND
DB-30RX1 (65 - 70)		ND	Decreasing	ND
DB-30RX2 (95 - 100)		ND	Decreasing	ND
DB-30RX3 (110 - 115)		ND	Decreasing	ND
DB-30RX4 (130 - 135)		ND	Decreasing	ND
DB-31RX1 (57 - 67)		Decreasing	No Trend	ND
DB-31RX2 (73 - 78)		ND	Stable	ND
DB-31RX3 (102 - 107)		ND	Decreasing	ND
DB-31RX4 (130 - 135)		No Trend	No Trend	ND
MW-06 (15 - 30)		Decreasing	Decreasing	Decreasing
MW-11R (10 - 15)		Decreasing	Decreasing	Decreasing
MW-19 (15 - 20)		Potentially Decreasing	Decreasing	No Trend
MW-22 (30 - 40)		ND	ND	ND
MW-23 (15 - 30)		NS	NS	NS
MW-24 (10 - 25)		Decreasing	Decreasing	Stable
MW-25R (30 - 35)		Decreasing	Decreasing	No Trend
MW-35D (30 - 35)		Decreasing	Decreasing	No Trend
MW-35S (15 - 20)		Decreasing	Decreasing	No Trend
MW-36D (27 - 32)		Decreasing	ND	Decreasing
MW-37D (25 - 30)		NS	NS	NS
MW-9RD (30 - 35)		No Trend	Decreasing	No Trend
MW-9RS (20 - 25)		Decreasing	ND	No Trend

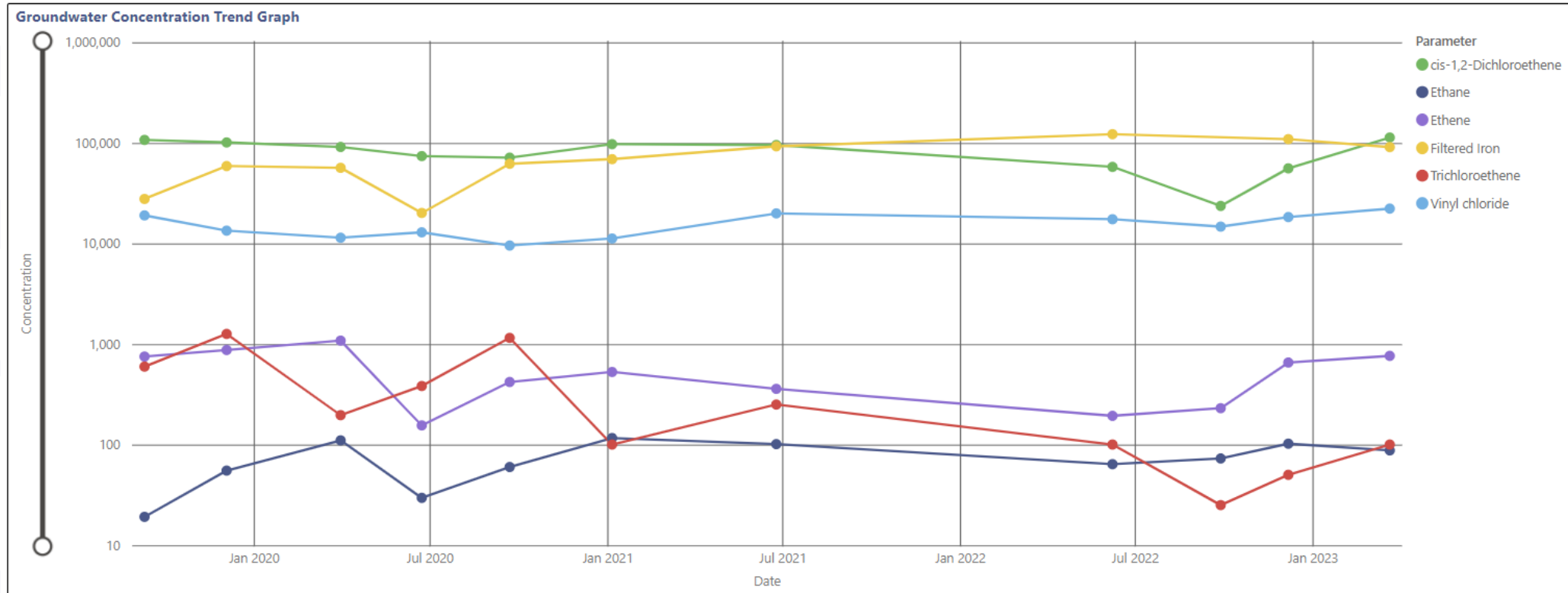
MW-19



Parameter Group:
 Parameter:
 Location Tp., Well Tp., Abandon...:

Result Type:
 Site/Area:
 Sample/Screen:

Parameter	MK Result	S	COV	# of Detections	P	Stan. Dev.
Trichloroethene	Decreasing	-32	1.15	5	0.99	12.85
Ethane	No Trend	21	0.43	11	0.94	12.85
Filtered Iron	No Trend	29	0.47	10	0.99	11.18
Vinyl chloride	No Trend	15	0.27	11	0.86	12.85
cis-1,2-Dichloroethene	Potentially Decreasing	-21	0.33	11	0.94	12.85
Ethene	Stable	-7	0.56	11	0.68	12.85



Summary

→ Lessons learned

- ▶ Data analysis & reporting tools – incredibly powerful!
- ▶ Data collection tools – more difficult to implement & link to database

→ Next steps

- ▶ Improve automated workflows for data collection & database imports
- ▶ Add dashboard tools for analytics
 - » Molar concentrations
 - » Summaries: COCs list, # of detections per compound, etc.
- ▶ Improved summary table workflows
- ▶ Increase database standardization



Thank You!

Ralph Simon
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