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Data Analytics Automation to Support Pump and Treat Shutdown Evaluation

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RemTech™ Symposium, 11 October 2023

Agenda

- Introduction
  - Why automate data analysis and decision making?
  - What does data analytics automation look like?
  - How is automation done?
- Plume stability evaluation (PSE) case study
  - Objectives of the pump and treat shutdown evaluation
  - Project-specific data flows
  - Scope of automation
  - Results
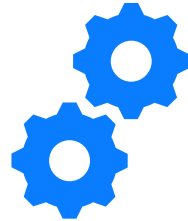- Technology-level takeaway messages
- Look to the future of automation
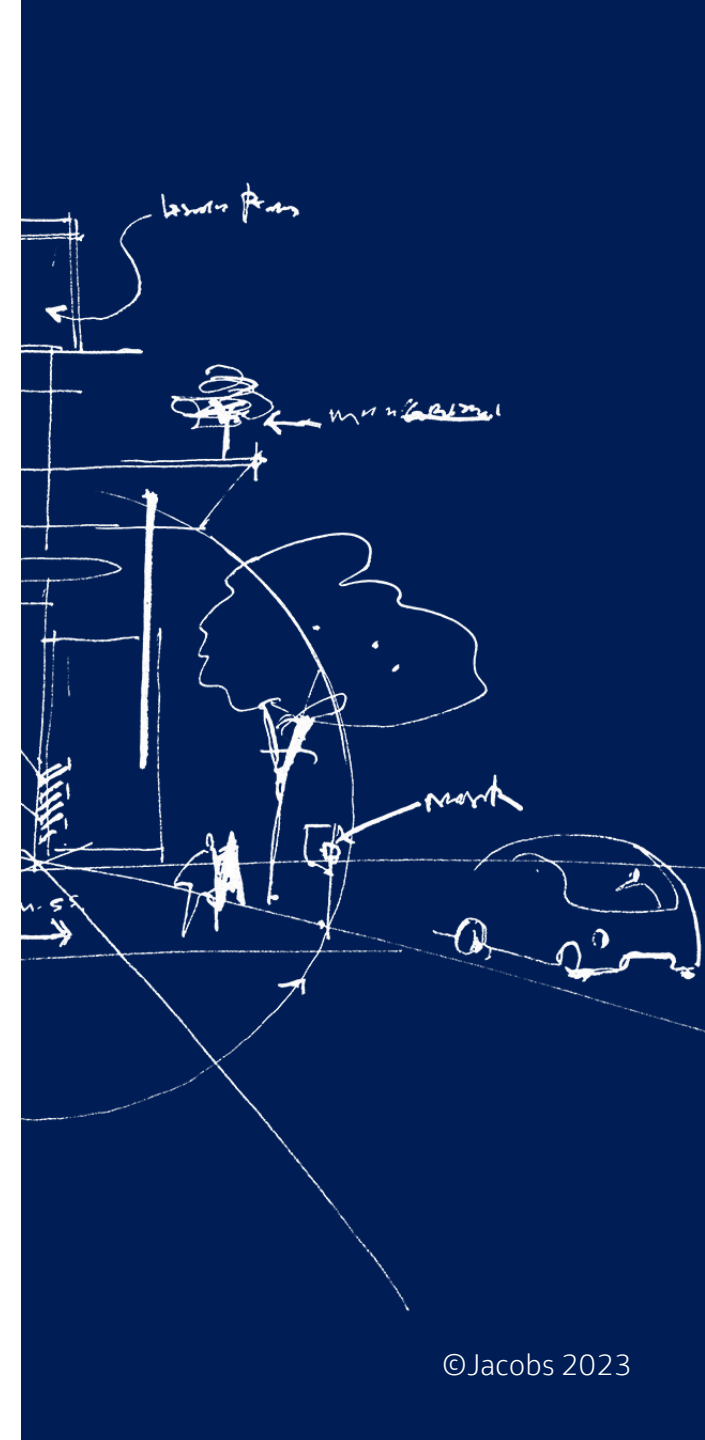
Introduction – Why automate data analysis and decision making?

Improve efficiency

Do more with less

Improve processes

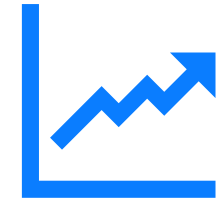Upgrade tools and techniques

Improve data quality

Keep up with large data streams

Maintain a well-informed project team

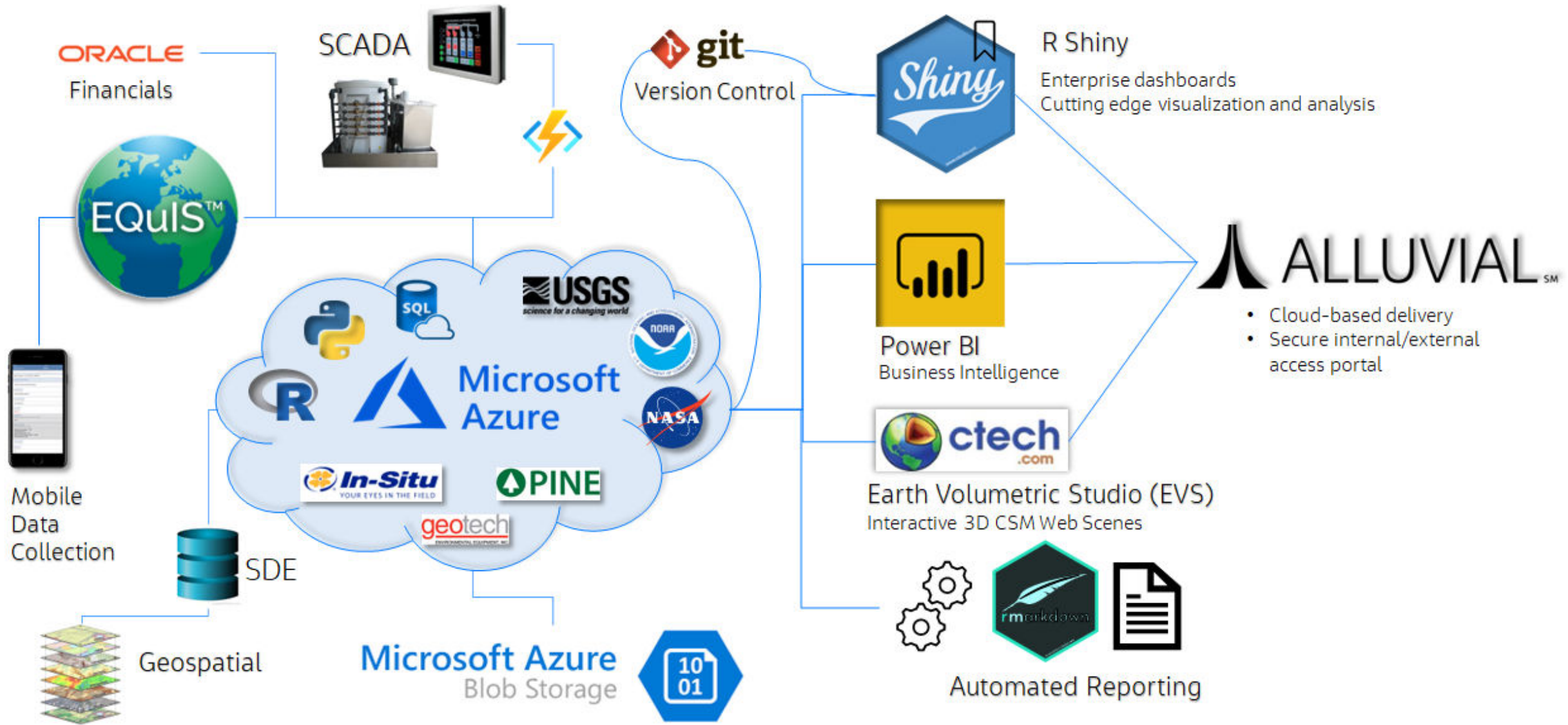Enable real-time decision making

Minimize hang-ups due to slow data analysis

Drive better decisions

Increased data scrutiny

Better defined decision logic

What does data analytics automation look like?

How is automation done?

It starts with a set of environmental questions, data objectives, and clear decision needs

A database is required to access validated data input and store data analysis output

Code is written to process and analyze data and generate conclusions with minimal human intervention

Using programming languages such as Python and R

For ease of team access to results, a graphical data analytics dashboard is commonly used

Dashboard software options include R-Shiny, PowerBI, and Tableau

Web-based applications and cloud computing can greatly improve team access and data processing speed

Plume stability evaluation (PSE) automation case study

- Former industrial facility on an island in the Caribbean
- For ~30-years, a pump and treat (P&T) system addressed a contaminated groundwater plume containing petroleum-based DNAPL (petroDNAPL)
  - Aged and diminished in effectiveness, required off-island disposal of a hazardous waste
- Hypothesis formed and lines of evidence provided to support a shutdown and plume stability evaluation
- Regulator granted approval to shut down P&T system for 3-years for PSE of petroDNAPL and associated groundwater plume

Objectives of the pump and treat shutdown evaluation
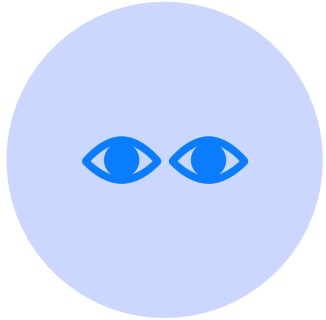
Observe petroDNAPL distribution and dissolved contaminant concentrations under ambient conditions without pumping

Quantify the potential for plume expansion without P&T

Evaluate the effectiveness of natural processes to contain the petroDNAPL and dissolved phase impacts

Establish a baseline for transition to an alternative remedy

Unacceptable instability decision criteria

- Monitoring data compared with clear instability criteria to generate PSE conclusions

		Unacceptable Condition	Criteria
petroDNAPL	Primary	Offsite petroDNAPL migration (lateral)	New petroDNAPL observation in wells without prior in-well petroDNAPL detection and "clean" soil boring logs
		Offsite petroDNAPL migration (vertical)	New petroDNAPL observation in well screens that appear vertically disconnected from observed petroDNAPL in soil boring logs and without prior in-well petroDNAPL detection
		Onsite petroDNAPL migration (laterally distal)	New petroDNAPL observation in distal, downgradient wells without prior in-well petroDNAPL detection and "clean" soil boring logs
	Secondary	Onsite petroDNAPL mobility (potentially non-migrating)	New petroDNAPL observation in wells previously noted as containing petroDNAPL
		Onsite petroDNAPL migration (vertical)	New petroDNAPL observation in well screens that appear vertically disconnected from observed petroDNAPL in soil boring logs and without prior in-well petroDNAPL detection
Dissolved-Phase	Primary	Offsite migration of multiple COCs	Exceedance in well without prior exceedances and "clean" soil boring logs
		Onsite migration of multiple COCs (distal)	Exceedance in south perimeter well
	Secondary	Onsite dissolved COC migration	Exceedance in downgradient wells without prior exceedances and "clean" soil boring logs
		Onsite dissolved COC migration	Exceedance AND statistically significant increasing trends by MK in wells proximal to petroDNAPL footprint without prior exceedances

		Onsite dissolved COC migration	Thiessen polygons and plume moment analysis show:
			  - a statistically significant increase (i.e., p-value < 0.05) in Unit 2 plume mass, AND
			  - a consistently, downgradient advancing center of mass that has traveled greater than 30% the baseline and post-earthquake plume length

Project-specific data and workflows

- On the order of 100,000 data records were evaluated at a high frequency to support decision making throughout the PSE
- Daily to weekly data flows were completely digitized from field to database including:
  - In-well petroDNAPL thickness
  - Groundwater analytical data (16 contaminants of concern, multitude water quality parameters)
  - Daily rainfall
  - Earthquake occurrences
- Inventory scripts (code) were developed to inventory and QC data
- Evaluation of stability decision criteria was automated using logic scripts, hosted in web-based dashboard which also automatically updated visuals, data plots, plume maps, and other reports

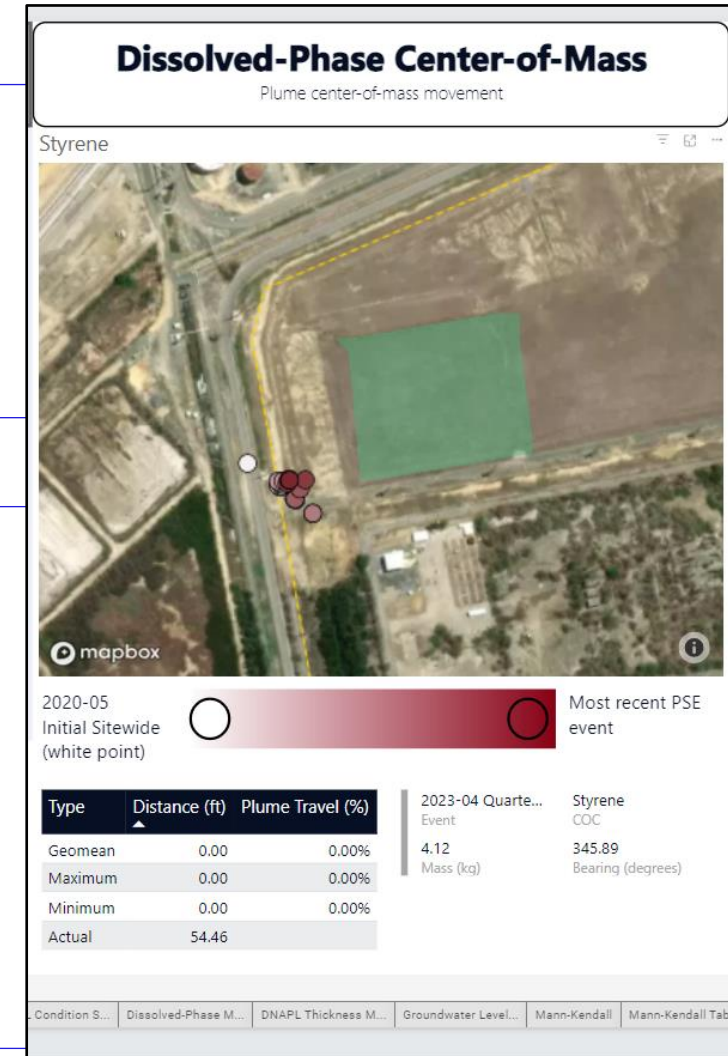Field ➡ Database ➡ Decision Criteria Script ➡ Dashboard Summary

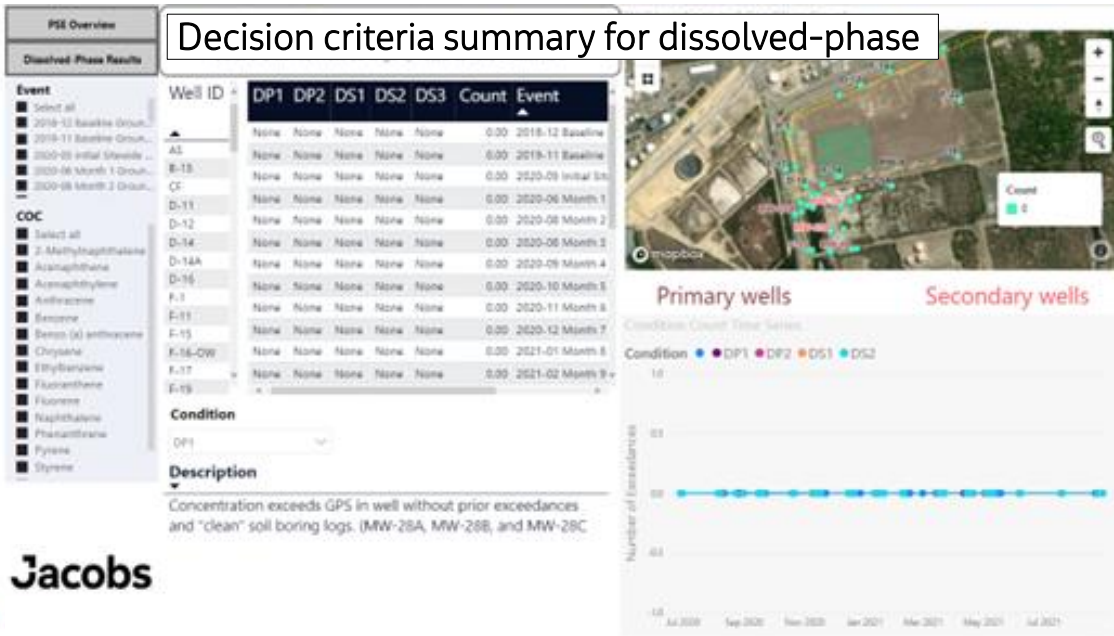# Scope of automation for data analytics and decision making

Automated data analytics

- Mann-Kendall trend statistics
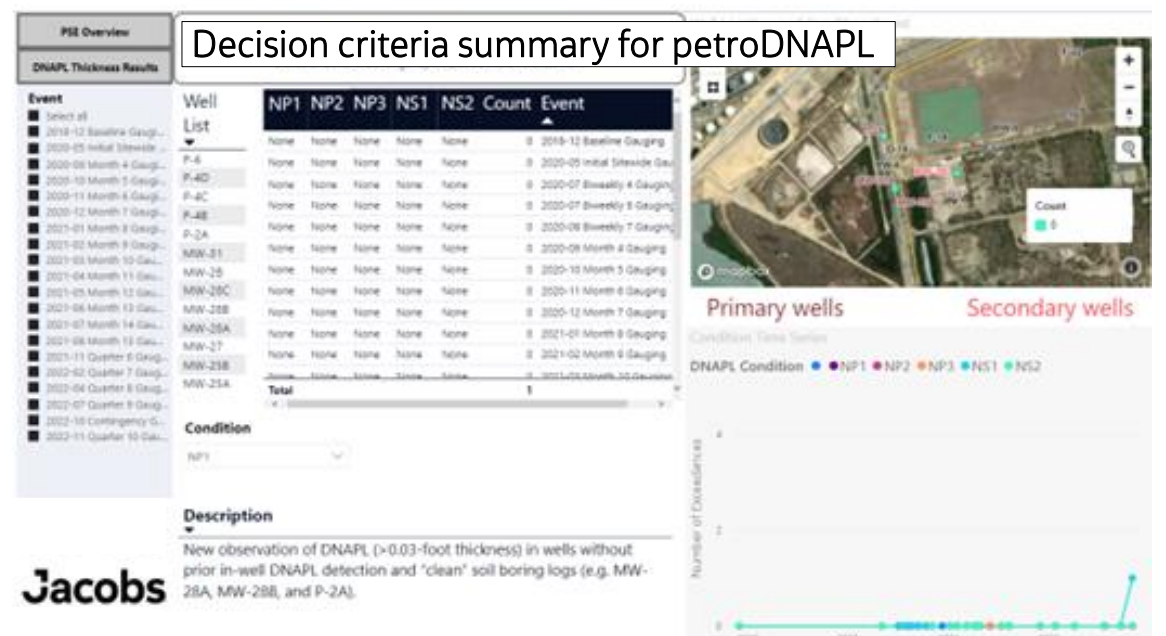- Thiessen polygon plume moment calculations – mass and center of mass

Automated decisions

- Identification of unacceptable conditions for in-well petroDNAPL presence in "trigger" wells
- Identification of unacceptable dissolved phase concentrations in "trigger" wells
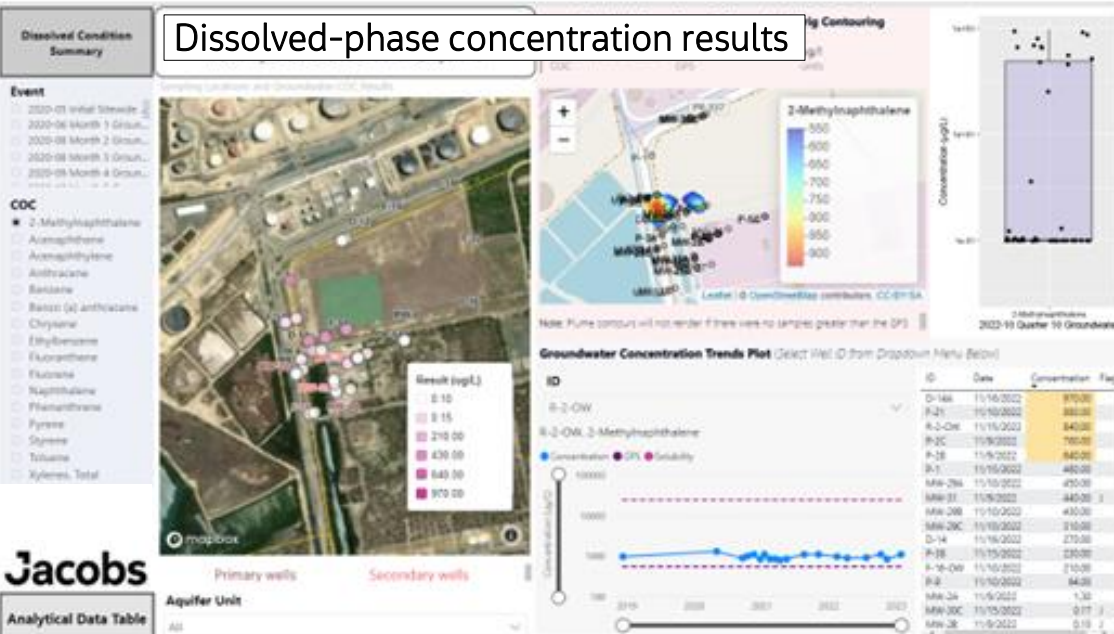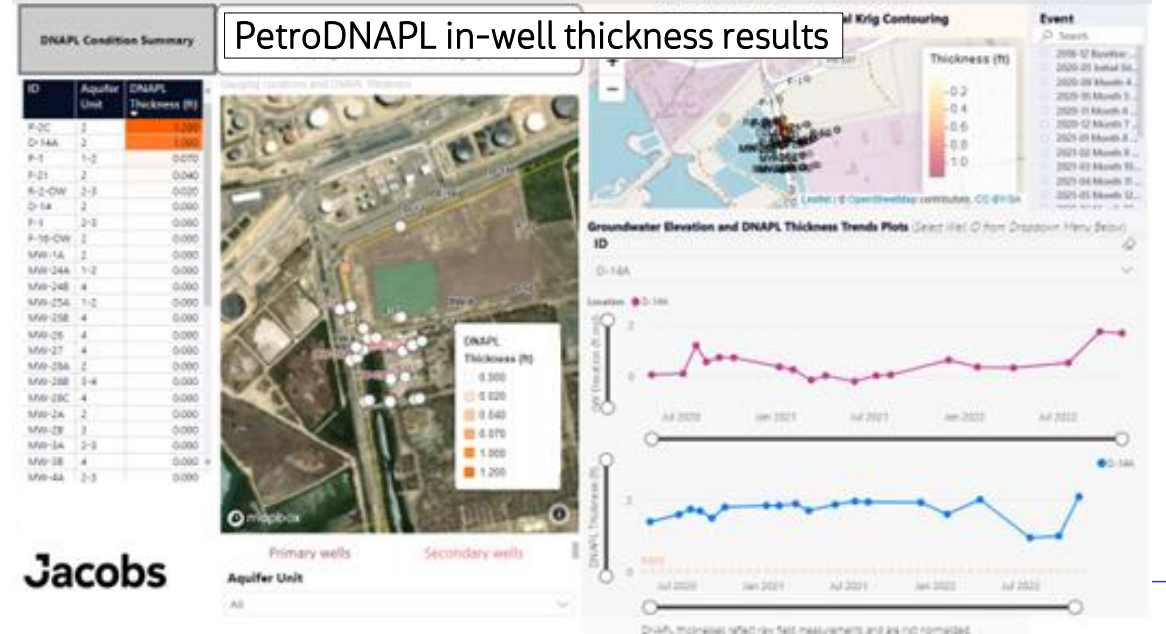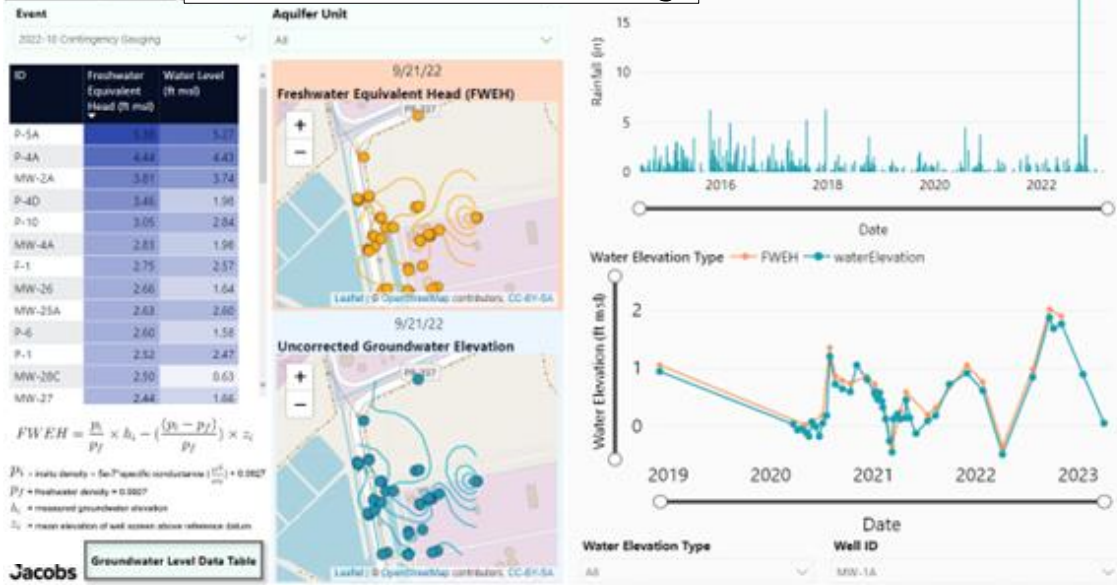- Identification of unacceptable dissolved phase geospatial distribution

Dissolved-Phase Center-of-Mass
Plume center-of-mass movement

Styrene

2020-05 Initial Sitewide (white point) — Most recent PSE event

Type	Distance (ft)	Plume Travel (%)
Geomean	0.00	0.00%
Maximum	0.00	0.00%
Minimum	0.00	0.00%
Actual	54.46	

2023-04 Quarte... Event — Styrene COC
4.12 Mass (kg) — 345.89 Bearing (degrees)

Decision criteria summary for dissolved-phase

Decision criteria summary for petroDNAPL

Dissolved-phase concentration results

PetroDNAPL in-well thickness results

Groundwater level monitoring
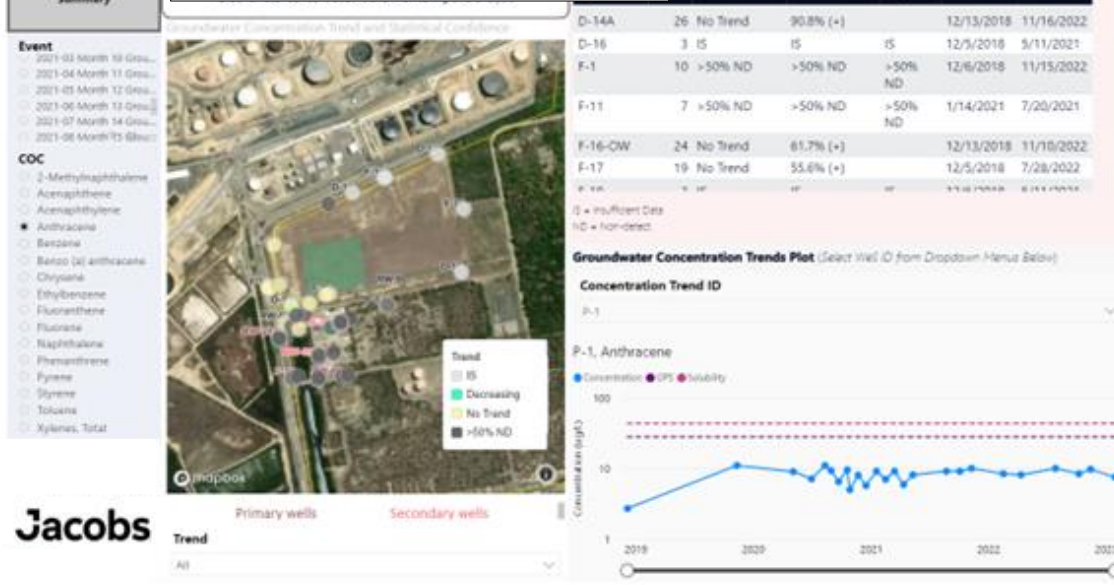
Mann-Kendall trend analysis
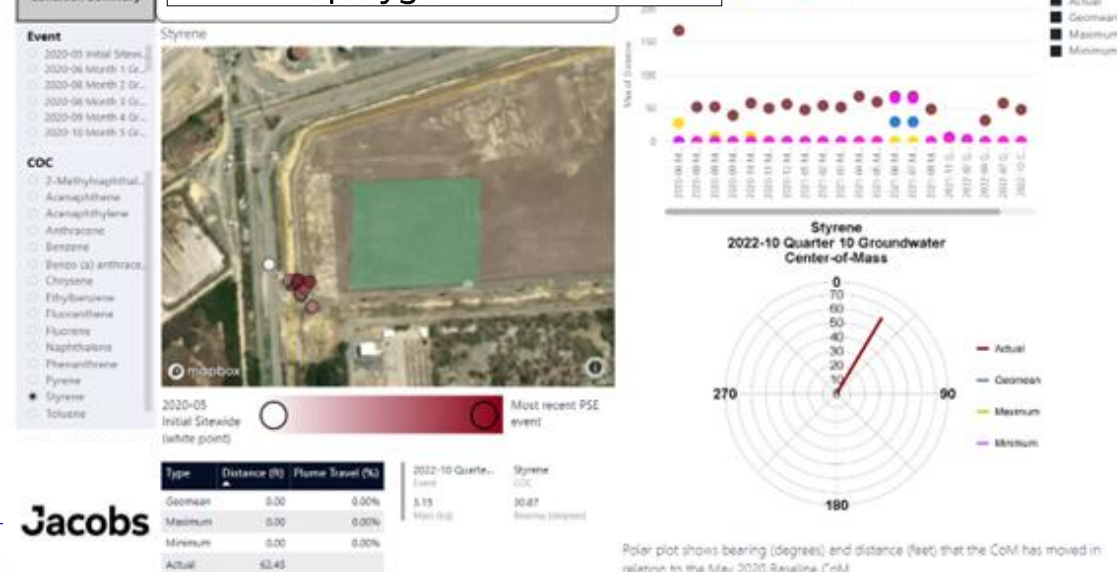
Thiessen polygon center of mass

Thiessen polygon total mass

Decision criteria summary for dissolved-phase
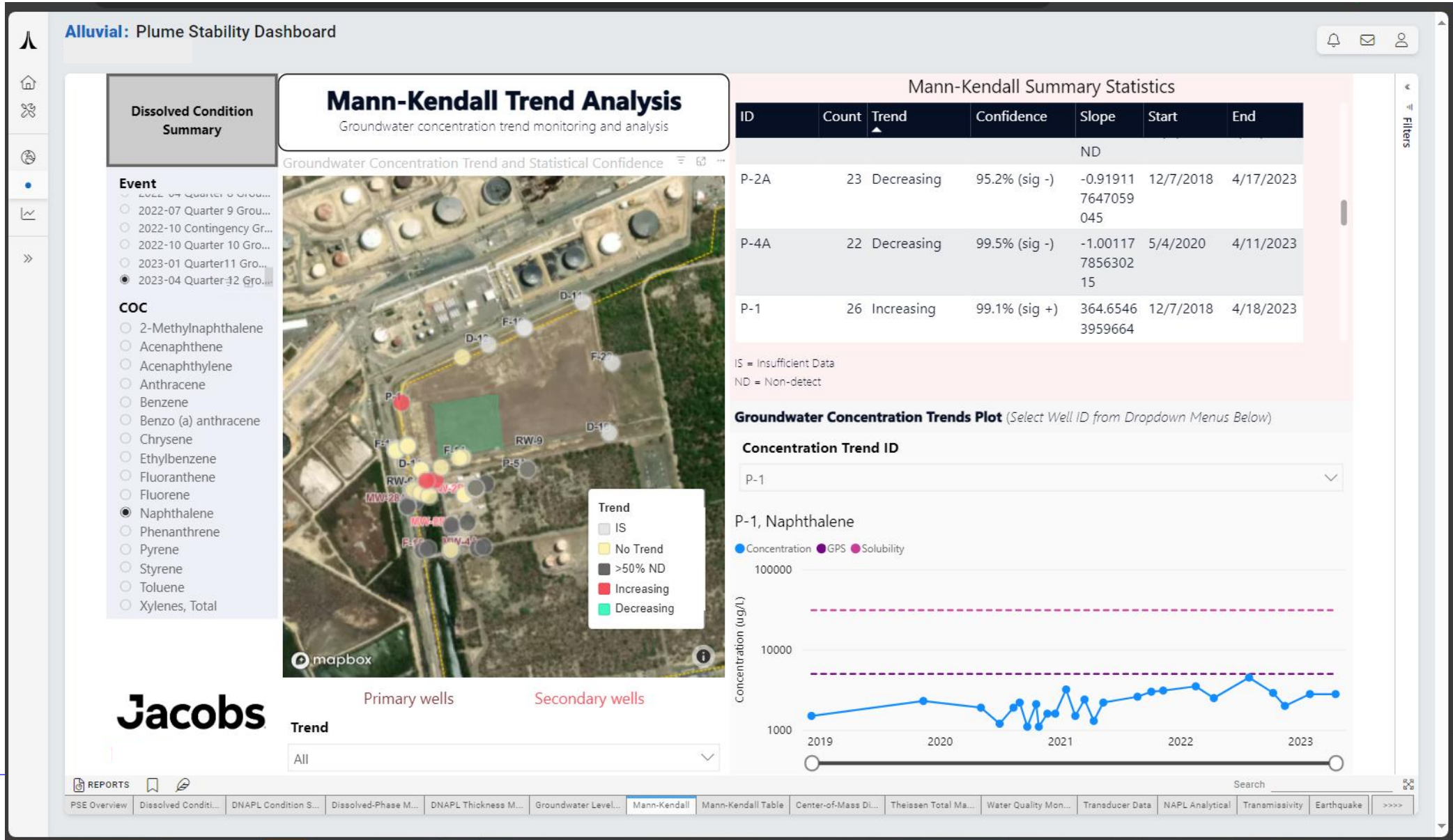
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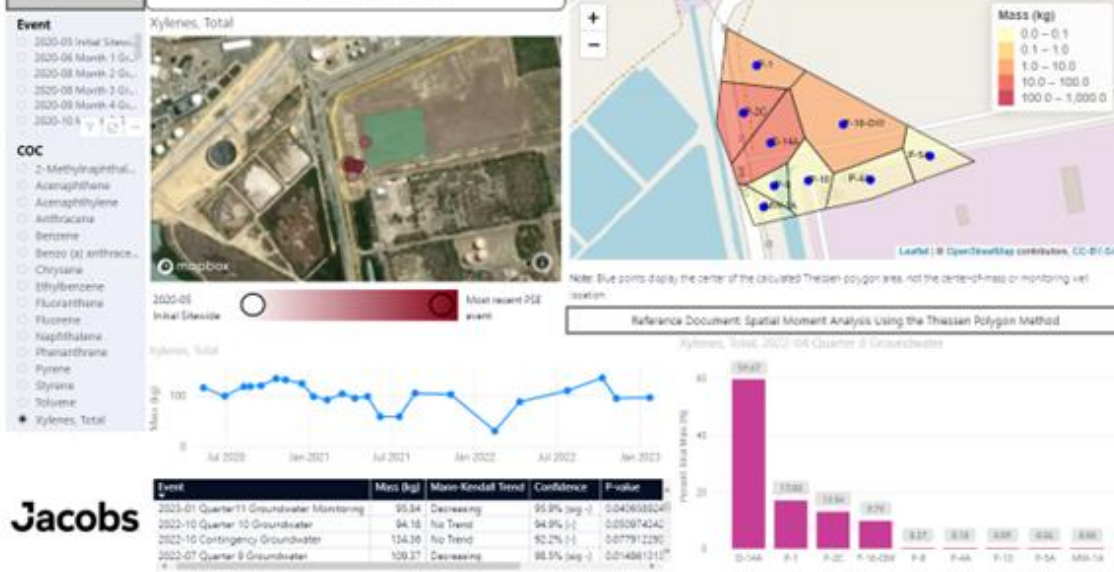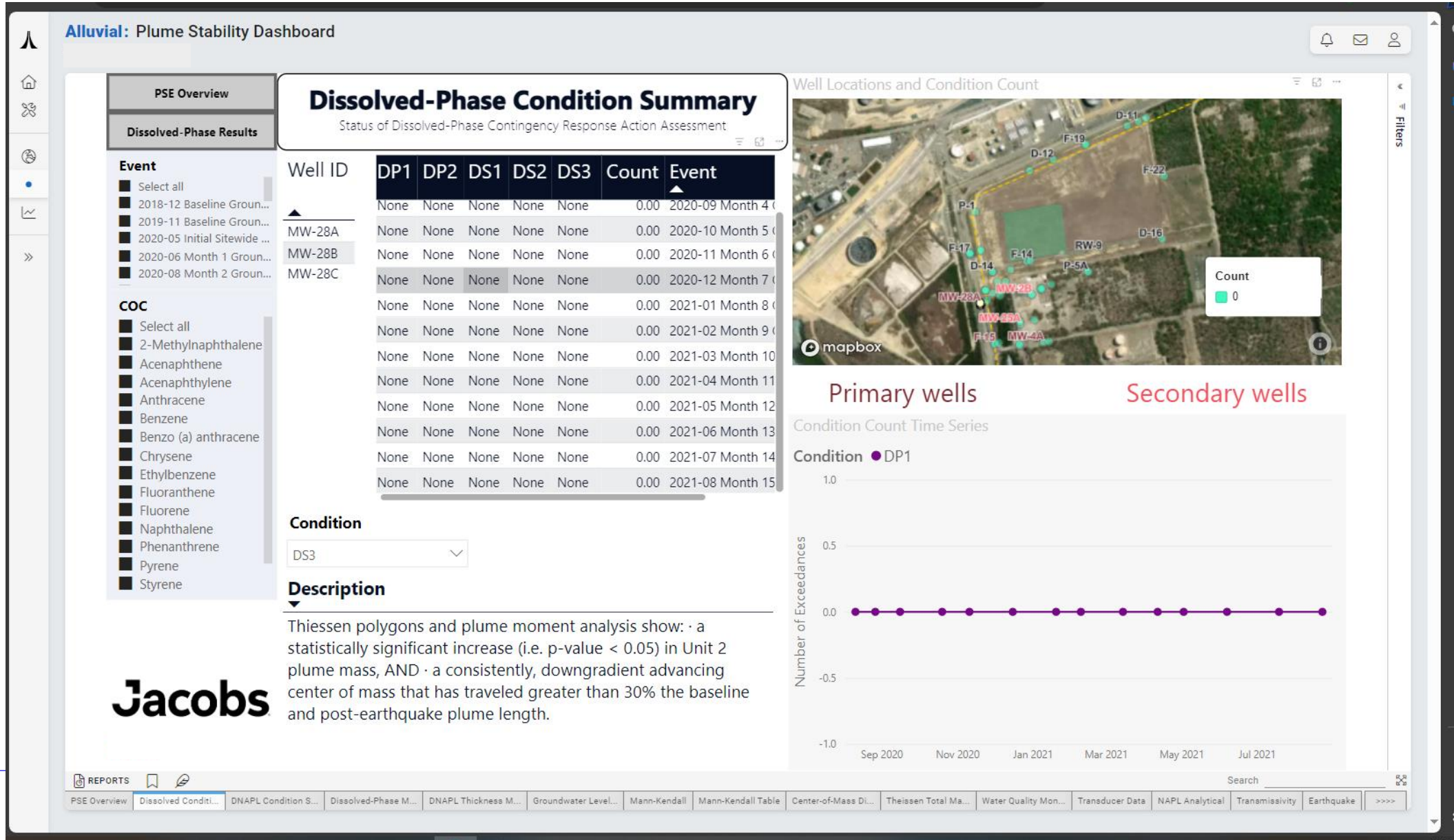
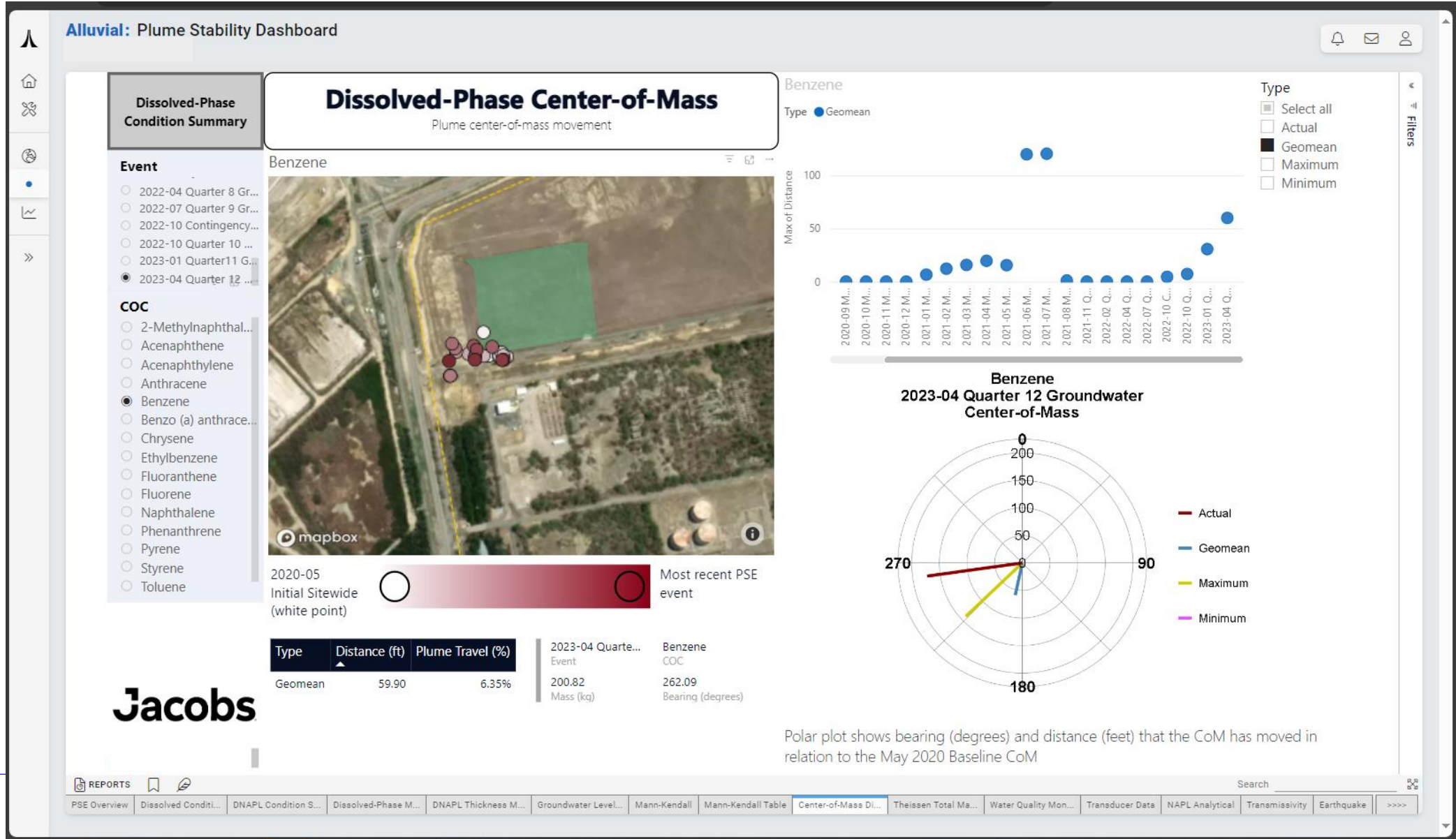# Dissolved-phase concentration results

Mann-Kendall trend analysis

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Thiessen polygon center of mass tracking

PSE automation case study – Results

- Data analytics automation successfully processed a very large data set to a firm conclusion
  - Output multiple lines of evidence to demonstrate plume stability
  - No primary unacceptable instability observed during P&T shutdown
    - Some dynamics in the secondary petroDNAPL conditions, but explained by site disturbances (i.e., earthquakes and hurricanes)
- Entire project team (including client and regulator) accessed the results and used the dashboard
  - Data analytics dashboard provided transparent access and facilitated regulatory concurrence on key decisions
- Results convinced the regulators to extend P&T system shutdown into remedy selection phase
- Reaffirmed value of digitization from field to report to provide the data needed to automate thorough decisions

Takeaway learnings

|		
Data analytics and decision automation is effective and powerful	Provides fast data evaluation results	Viable method for processing large site monitoring data streams
Drives 100% digitization of data streams used to make decisions	Requires humans – consistency, attentive database stewardship, and QC	Investment required, but ultimately reduces data evaluation costs

The EXCITING future of automation

Field sensors
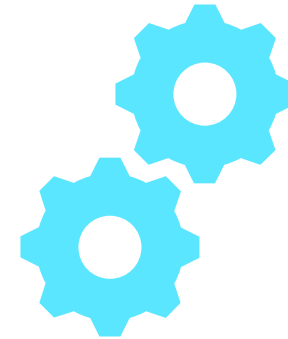
Report automation

The end.

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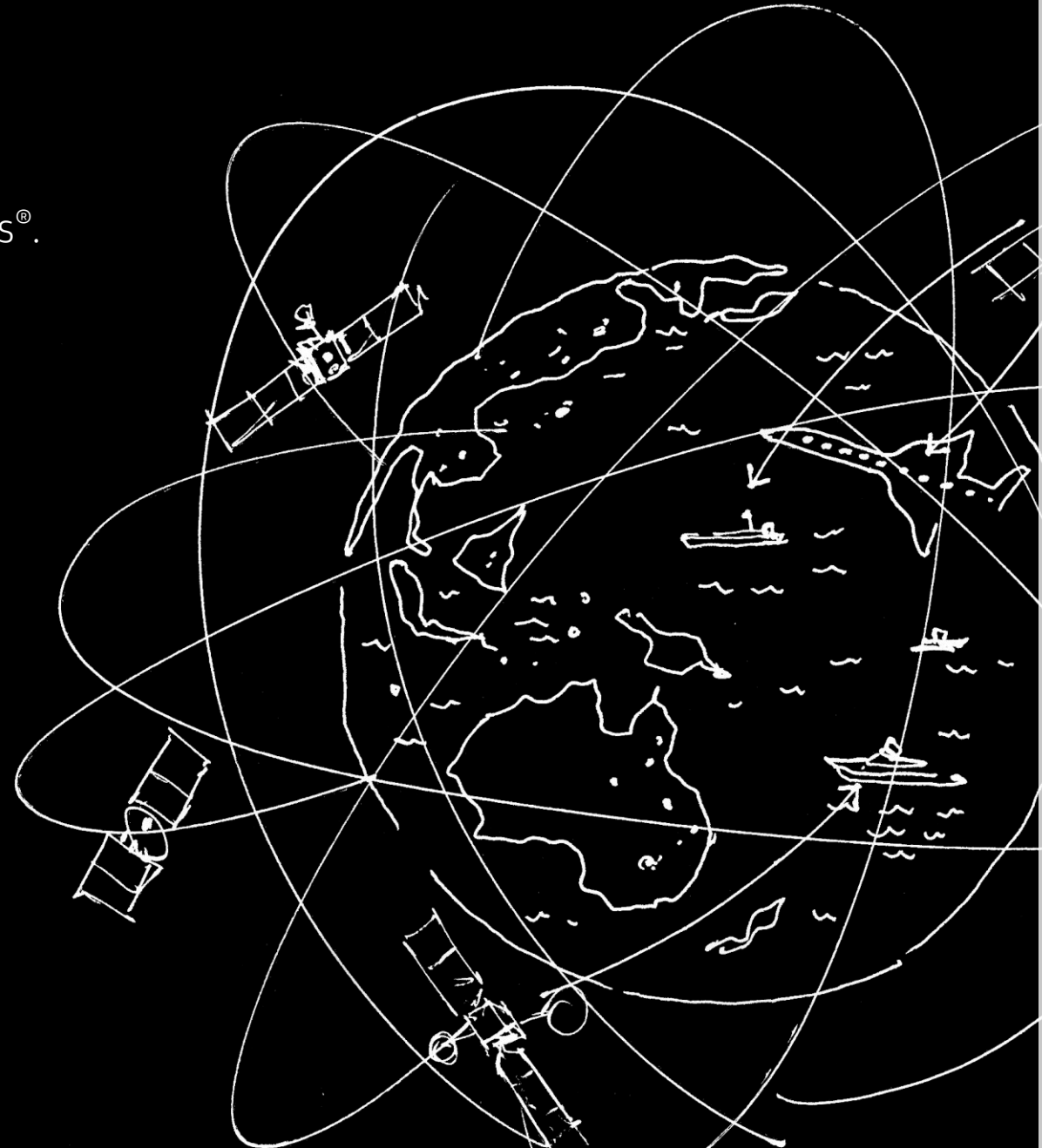
Thank you for listening.
Visit the Jacobs booth to discuss.

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How can data analytics automation apply throughout the remediation life cycle?

Catalog historical data, maps, photos

Rapid data assimilation and visualization

Capture, assimilate and evaluate remedial design and performance data

Better predict remediation time frames and lifecycle costs

Site Characterization Source Identification

H&E Risk Assessments

Conceptual Site Model

Feasibility Studies & Remedy Selection

Remedial Design

Remedy Implementation

O&M and Site Closure

Automate evaluation of site data against latest toxicity data

Capture and assess site cleanup cost data

Capture cost, schedule, and contractor/vendor info

Using IoT sensors for automated, real-time data collection