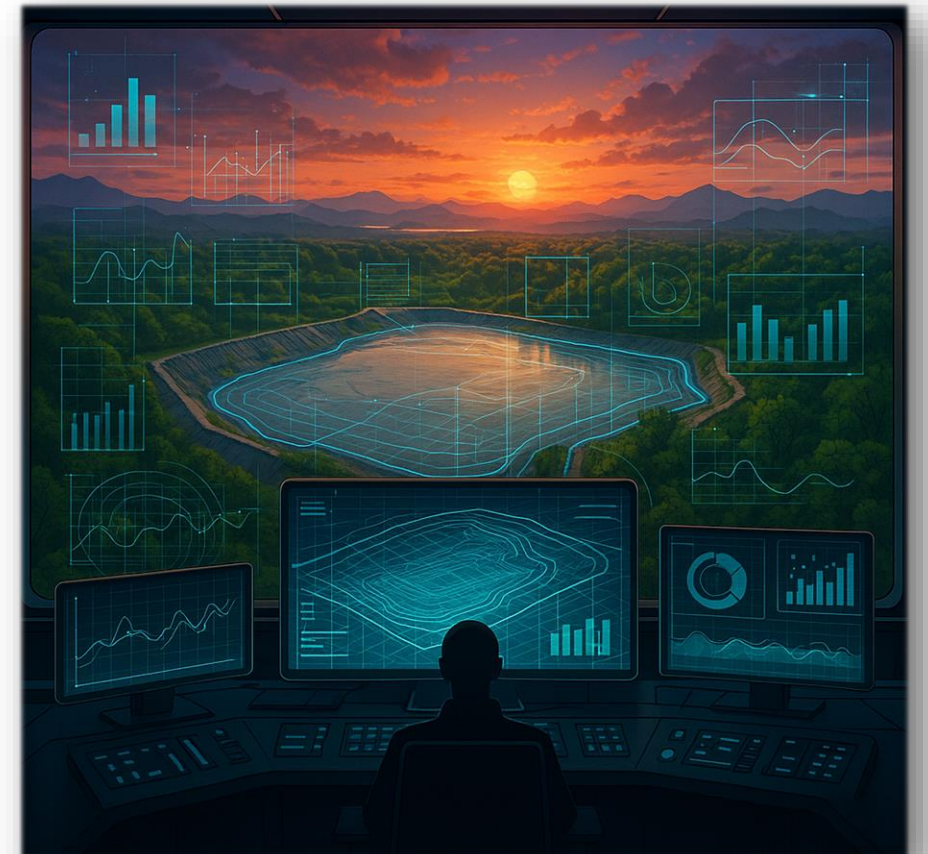


Advancements in TSF Monitoring and Surveillance Through the Adoption of Digital Solutions



Putting digital technology to work

- Technology has always played an important role in the mining industry.
 - With new emerging risks, more rigorous standards, and greater expectations from stakeholders, the use of technology will be essential in overcoming the challenges faced by the mining industry.
- This presentation will focus on;
 - Tailings Storage Facility (TSF) monitoring & surveillance, and the advancements in monitoring through the adoption of digital solutions.
 - Lessons, benefits & opportunities for TSF performance monitoring and risk management, as well as continued innovation.



Source: AI Generated Image

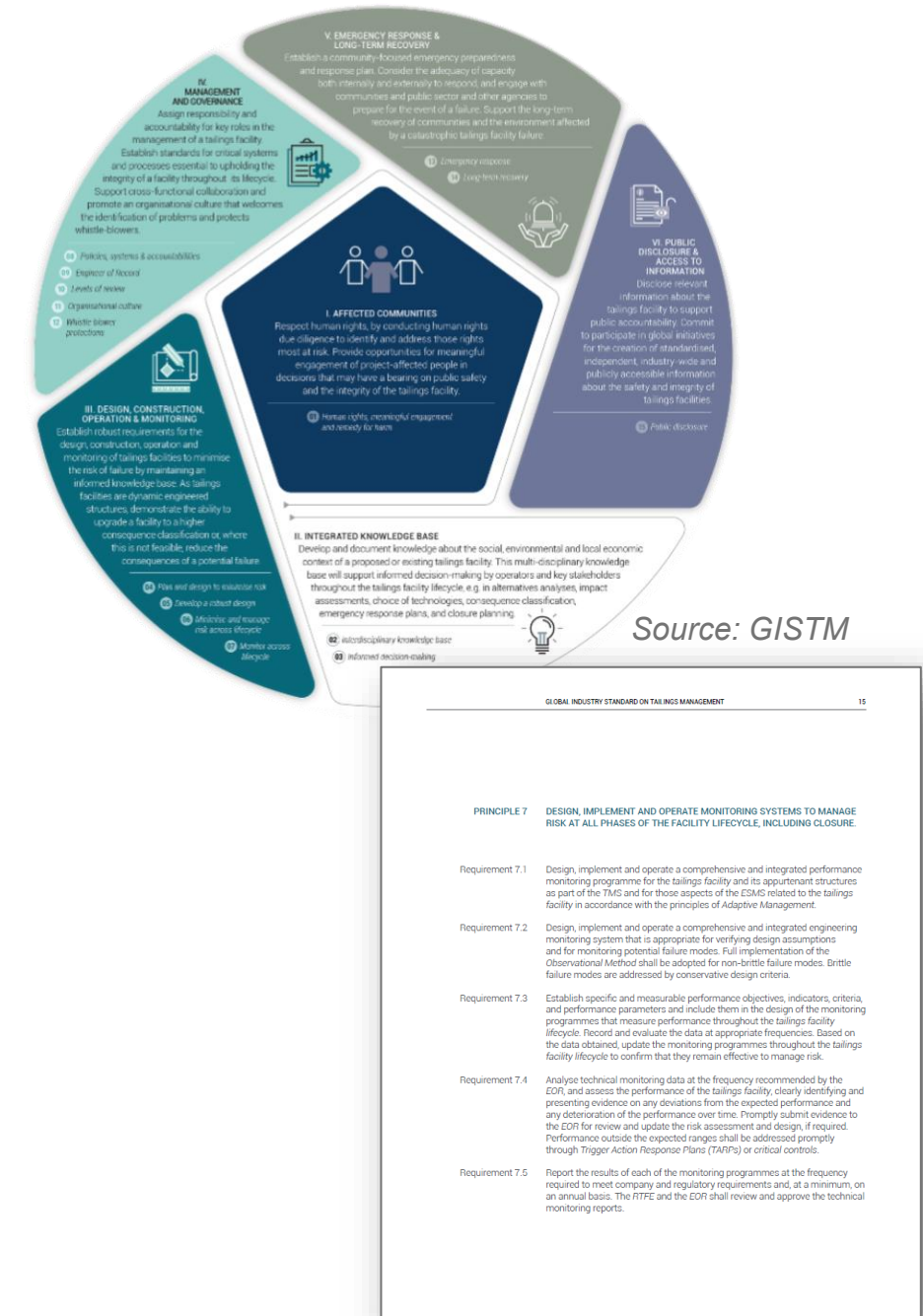
Drivers supporting digital transformation in TSF Monitoring & Surveillance

- Infrastructure & Technology
 - New emerging technologies
 - Internet of Things (IoT)
 - 5G and communications
- New Standards & Best Practice
 - GISTM
 - SANS 10286 Update
- Stakeholders
 - Investors, Shareholders & Insurers
 - Mining Communities



Framework

- GISTM: Topic 3, Principle 7 - Design, implement and operate monitoring systems to manage risk at all phases of the facility lifecycle, including closure.
 - 7.1: “Design, implement and operate a comprehensive and integrated performance monitoring programme for the tailings facility and its appurtenant structures.....”
 - 7.2: “Design, implement and operate a comprehensive and integrated engineering monitoring system that is appropriate for verifying design assumptions and for monitoring potential failure modes.....”
 - 7.4: “.... assess the performance of the tailings facility, clearly identifying and presenting evidence on any deviations from the expected performance and any deterioration of the performance over time”.

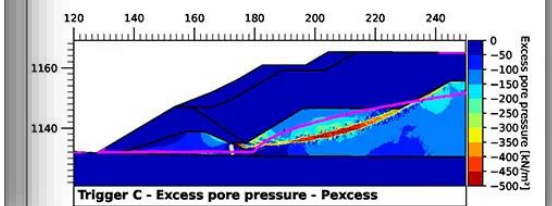
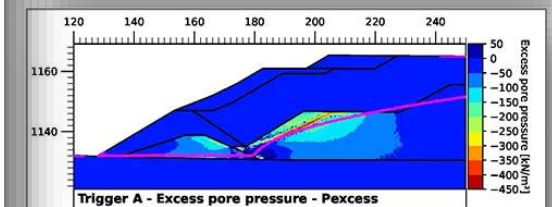
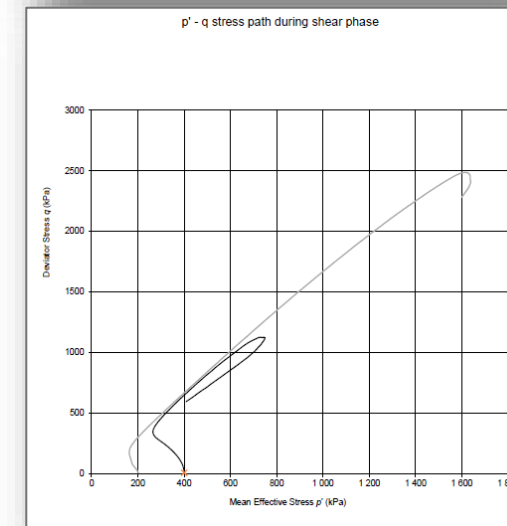
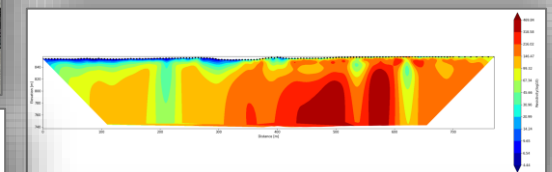
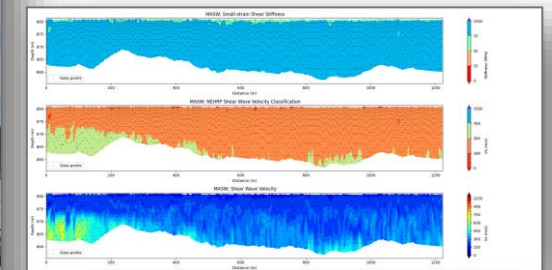


Knowledge base & Calibration

- TSF Design & Operation
 - Type and design of dam
 - Triggers & mode of failure
 - Aim to monitor and manage risks
- Investigations & Studies;
 - Geophysics
 - Geotechnical Investigation
 - Cone Penetration Test (CPTu) campaigns
 - Drilling campaigns
 - Laboratory Testing
 - Stability Analysis
 - Deformation Analysis (numerical modelling)



Source: SRK Consulting



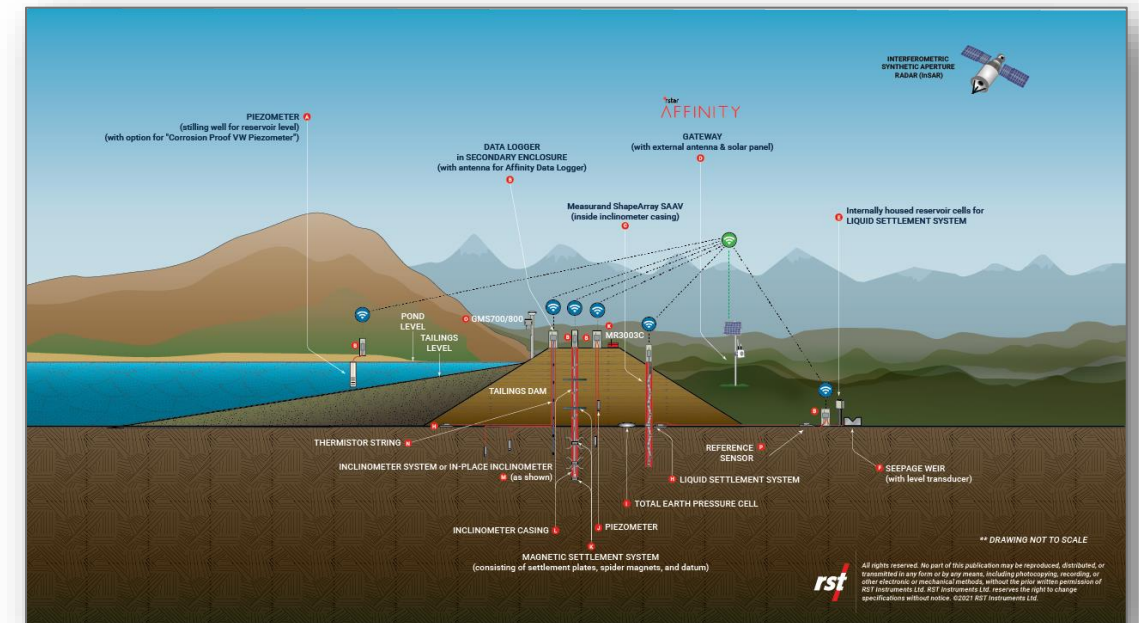
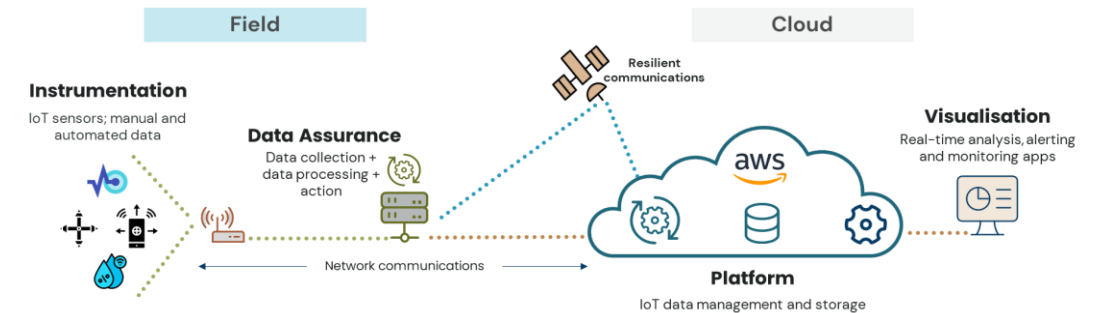
Robust Monitoring & Surveillance Solutions

- Solution Alignment
 - Technical
 - Implementation
 - Client/Vendor/Supplier/Contractor
- Quality Assurance & Quality Control
 - Manufacturing to Installation
- Operations & Implementation
 - Maintenance & critical spares
 - Scalability & integration
 - Resilience & Redundancy
 - Management - assign roles & responsibilities
- Monitoring & Surveillance Plan
- Training, technical support and services



- IoT Hardware; loggers & gateways
- Networks (integration) & Cloud storage
- Digital Dashboards

Source: Insight Terra



Source: RST Instruments

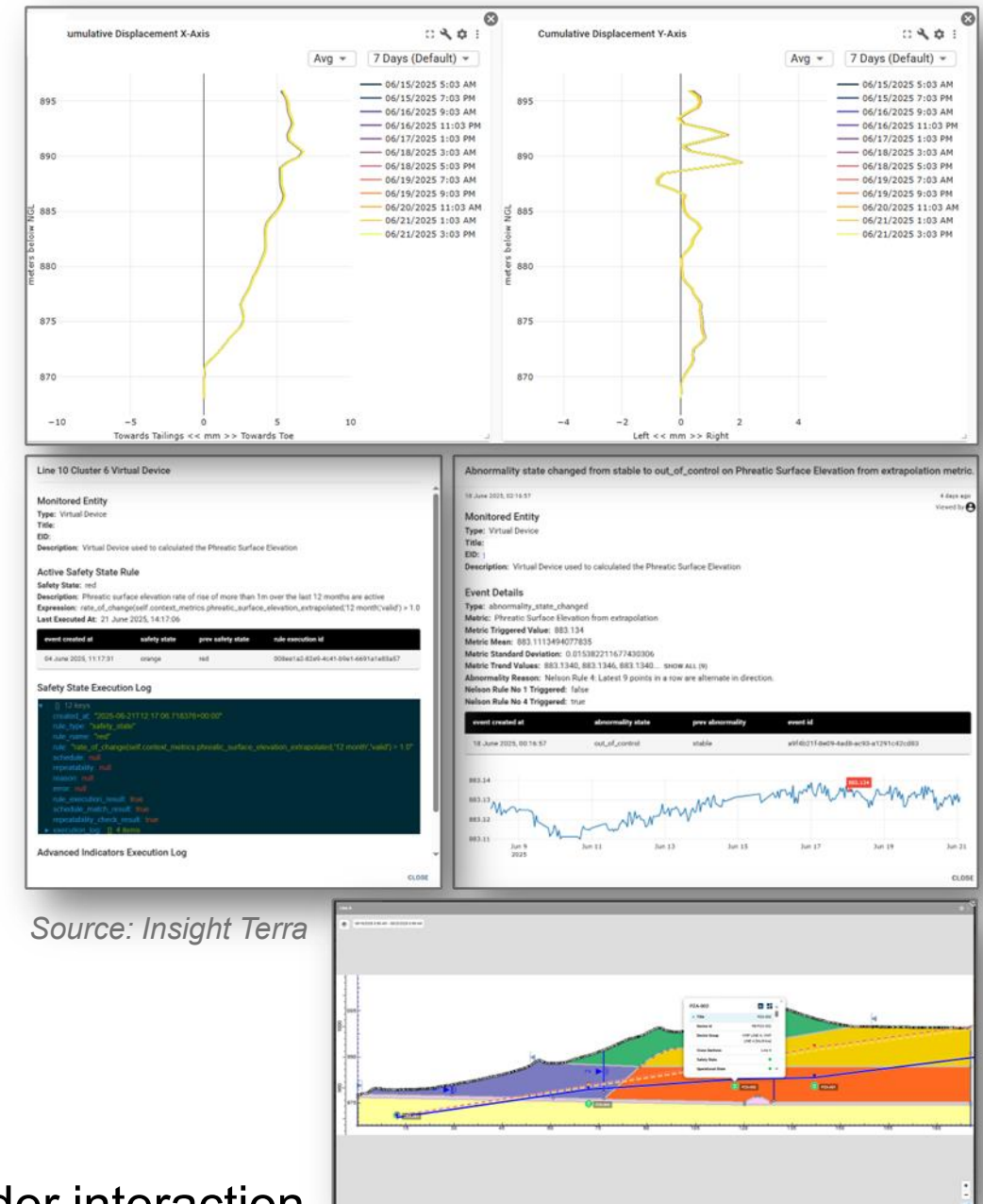
Digital Dashboards

■ Key Benefits

- Data collection, integration & aggregation
- Data validation and management (automation)
- Data visibility, transparent, assessable and auditable
- Supports change management

■ New Capabilities

- Digital rules and protocols
- Coding (automation, advanced analytics)
- Custom Digital Workflows
- Real-time analytics
- TARP Integration and risk management
- Instrumentation monitoring
- Communication: Reporting, notifications and stakeholder interaction



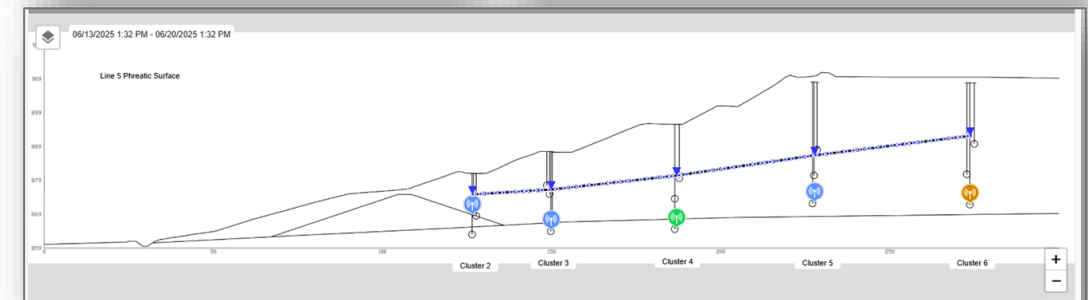
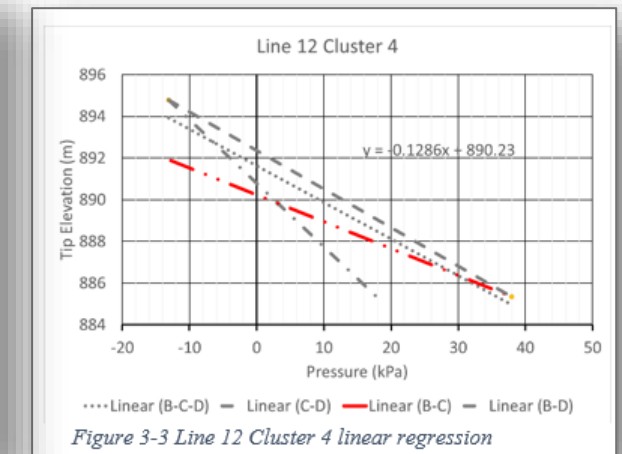
Source: Insight Terra

Applications: VWP Linear Regression Analysis

- Phreatic Surface Monitoring
 - The aim of this methodology is to simplify VWP pair selection and provide a degree of certainty/verification in chosen configurations. While also providing validation and metrics to underpin a cluster VWP pairing.
 - Calibrate model using CPTu testing.
 - Digital dashboards made it possible to process data rapidly and implement a recursive process to refine the linear regression VWP pairings.
 - Automated visualisation and review for potential changes in pressure which require recalibration of VWP linear regression pairs.

Table 3-4 Line 5 Cluster 5 pairings comparisons

Cluster 5		
	CPTu phreatic surface (mamsl)	CPTu Hydraulic Gradient (kPa)
	884.2	-7
Pairs	Calculated phreatic surface (mamsl)	Calculated hydraulic gradient (kPa)
C-B-A	888.462	-4.855
C-B	896.828	-1.528
B-A	884.15	-6.8
A-C	891.19	-4.283

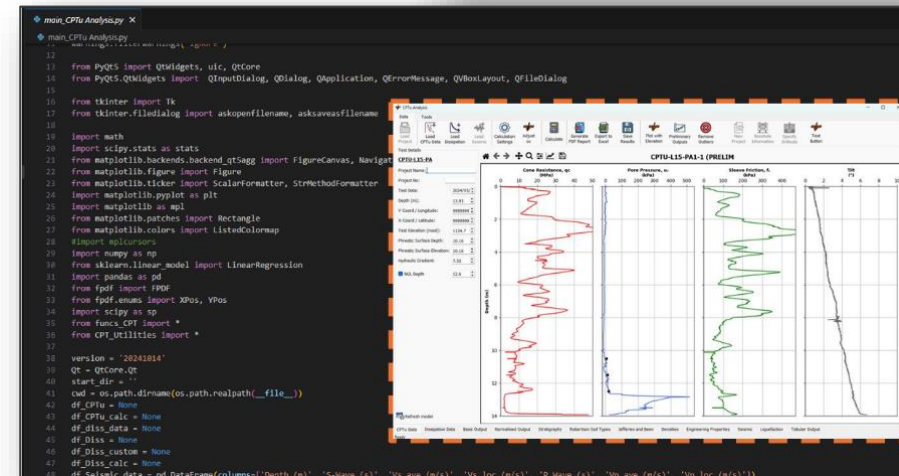
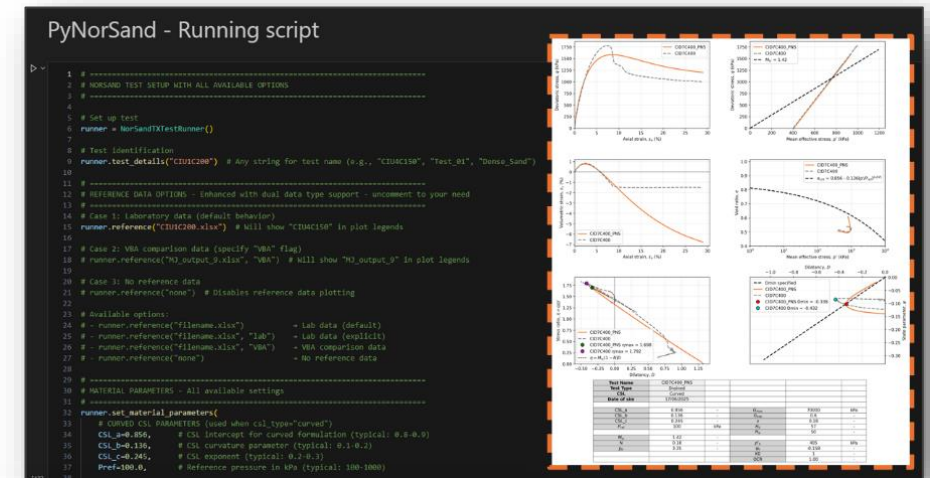


Source: SRK Consulting. C Meyer. (2024). Methodology for Determining Optimum Vibrating Wire Piezometer Pairing Relationships in VWP Monitoring Clusters.

Applications: Internal advancements through digital adoption



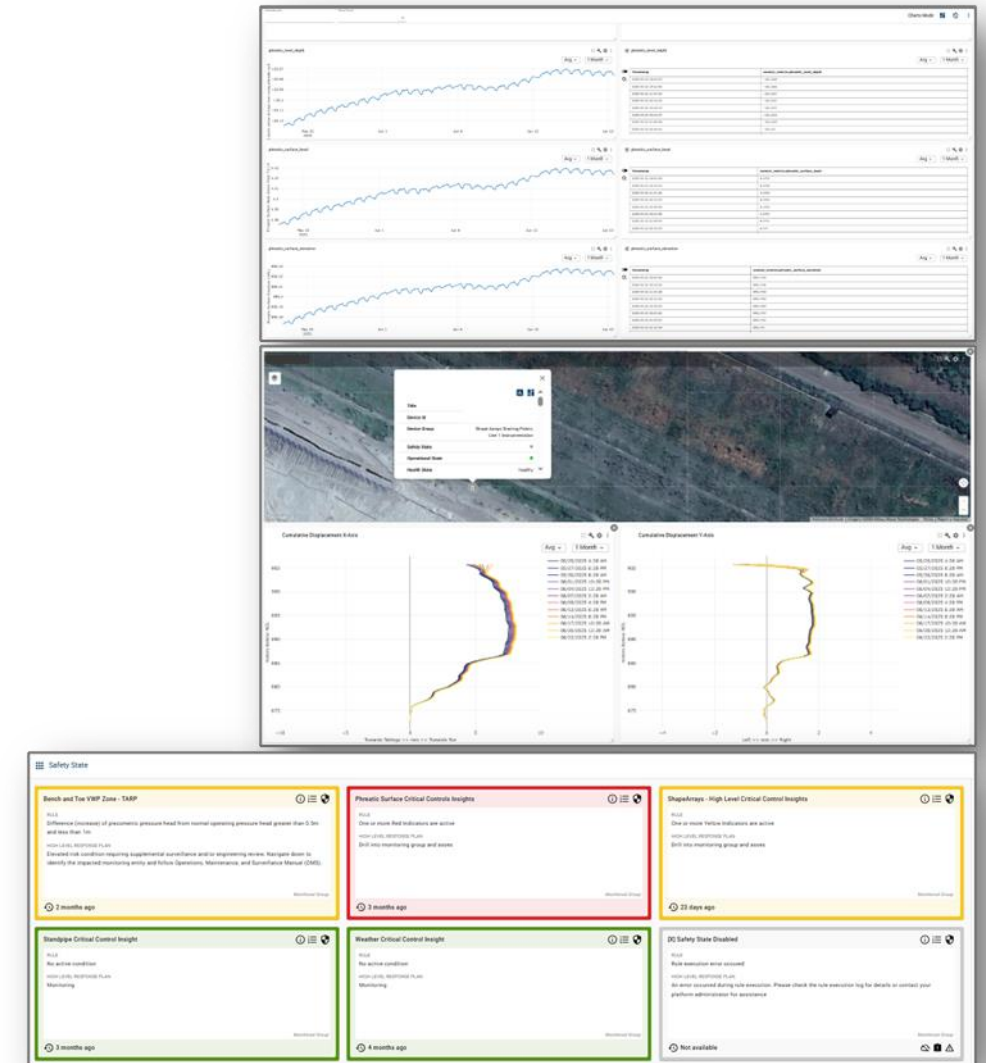
- Through the development of project needs we have been able to implement improvements and new methods to better perform monitoring and surveillance of TSFs.
 - Python coding & programming
 - Apply API/ ERP integration
 - Data storage, management & structuring
 - Streamline processes through automation
 - Applications for data analytics
 - Data visualisation and reporting



Source: SRK Consulting

Applications: Client & Project digital solutions

- SRK has worked and collaborated with our Clients on several TSF projects to support the development and implementation of their digital solutions and monitoring systems;
 - Supported on-site installation, integration and QA
 - Integrate new data sets and develop associated TARPS
 - Advised on visualisation and presentation of data
 - Develop dashboards and reports
 - Guide the development to align with standards
 - Research, development & innovation



Source: Insight Terra

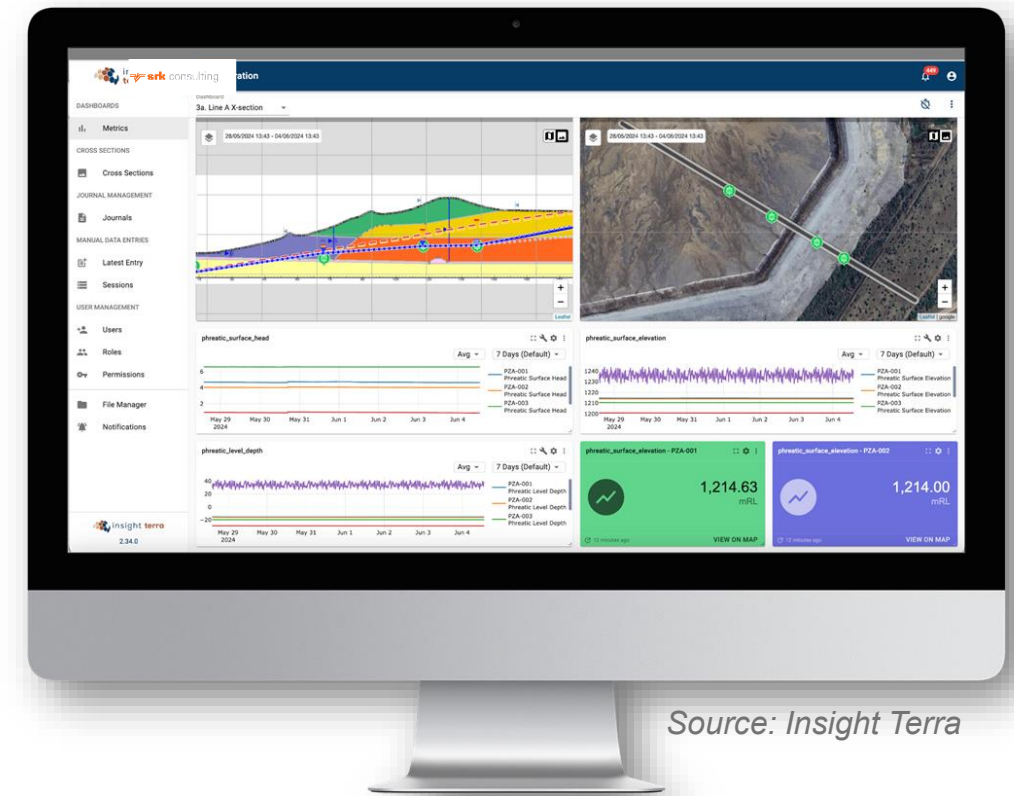
What Next for TSF Performance Monitoring?

- Technology
 - New monitoring methods; Passive Seismic Monitoring
 - AI, ML & Neural Networks
 - Advancements in predictive analytics
- Opportunities
 - New data insights
 - Better risk-based approach to TSF management
 - Increase knowledge base
- Challenges
 - Big Data
 - Data Security
 - Governance
 - Over-reliance ?



Final Thoughts

- Digital transformation and adoption in the TSF monitoring space is still evolving
 - Developing new capabilities in performance monitoring
 - New technologies and their applications
 - Better integrated data management and access
 - Improved risk monitoring and management
- Digital Dashboards
 - Clear benefits from leveraging these digital platforms. Mining professionals can better monitor performance, identify changes and potential risks, and make informed decisions to ensure safety and stability.



Source: Insight Terra

Final Thoughts

- Leveraging Technology
 - Leveraging current and new technologies, such as machine learning and AI, coupled with further industry collaboration and innovation, will play a strategic role in the next phase of this digital journey.
- Digital Adoption
 - Through continued innovation and adoption of new digital solutions, we create an opportunity to further enhance data acquisition methods, data analytics, and the quality of insights generated. This will further improve performance monitoring of TSFs and reduce risks.
- Word of caution - Technology never replaces good engineering judgement



Source: AI Generated Image

Thank You

Advancements in TSF Monitoring and Surveillance Through the Adoption of Digital Solutions

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- C Meyer

4th Digital Transformation In mining Conference 2025