

Rejuvenating Waterflood Reservoir in a Matured Brown Field – Subsurface Opportunities vs Operational Challenges

Mohd Fairuz Azman, Khiril Shahreza Salleh, Razali A Rashid, Tan Zhao Zheng, Luqman Hakim Zulkafli,
Nur Afiqah Ayub, M Naim M Noh, Nurul Hidayah Hasnan, Syarifah Nur Diyana



Objective

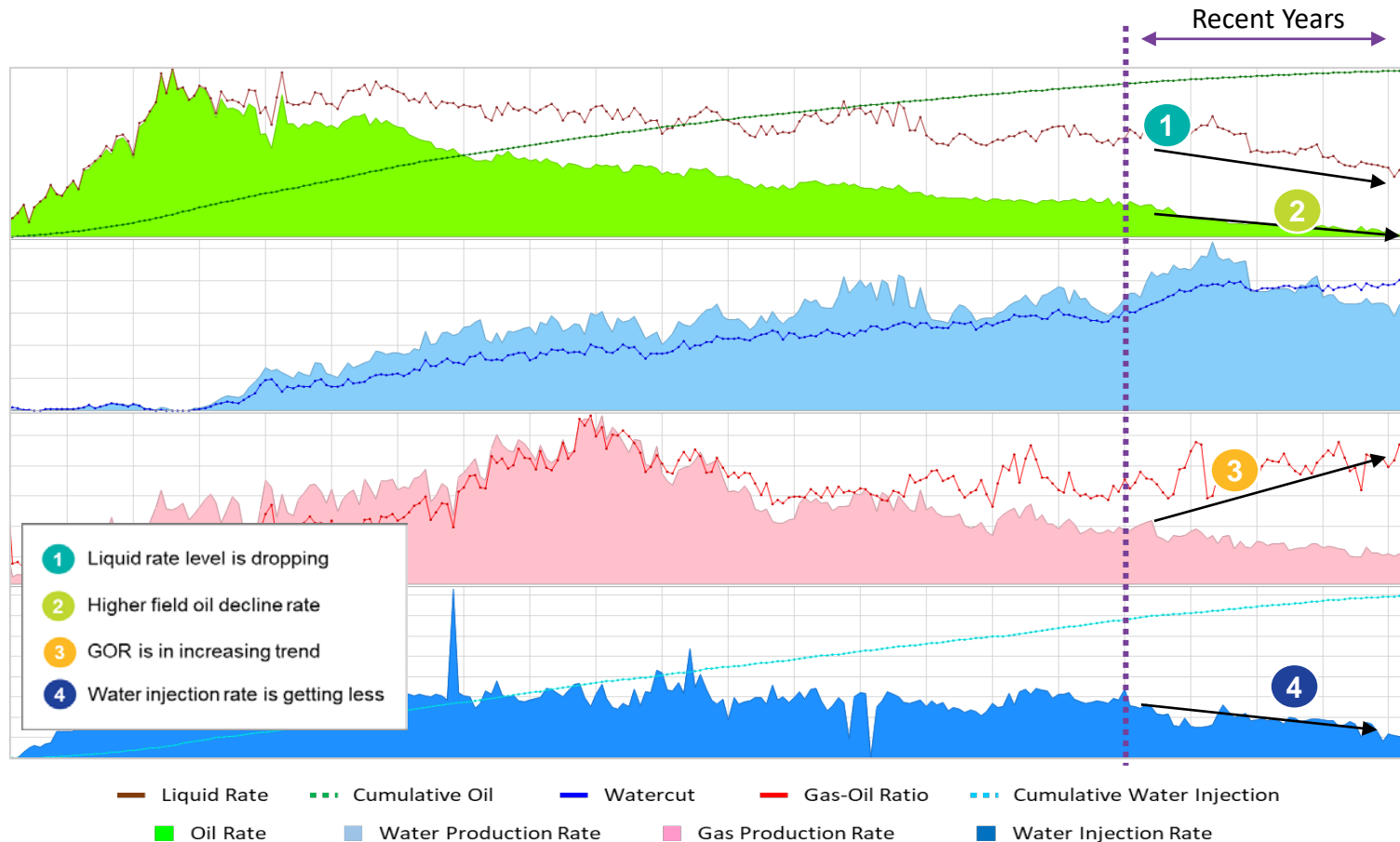
This paper highlights the challenges and best practices in rejuvenating water-injected reservoirs to improve field production, by integrating subsurface data acquisition and analytical evaluation with agile operational excellence support, to effectively manage water injection facilities and realize subsurface opportunities.

Presentation Outline



- Introduction
- Geological Complexity
- Establishing Flow Communication
- Identifying Optimization Opportunities
- Water Rejuvenation Plan
- Operational Challenges
- Field Production Improvement
- Conclusion

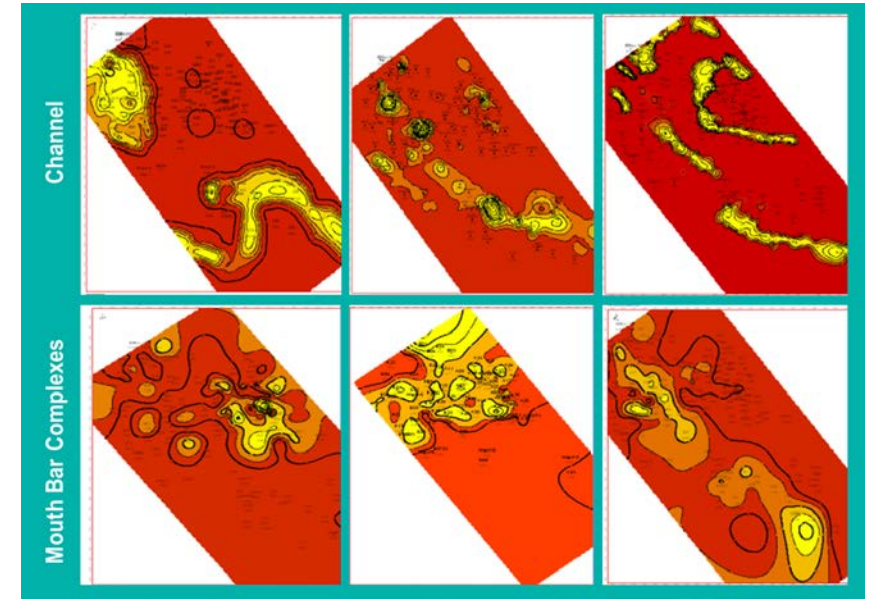
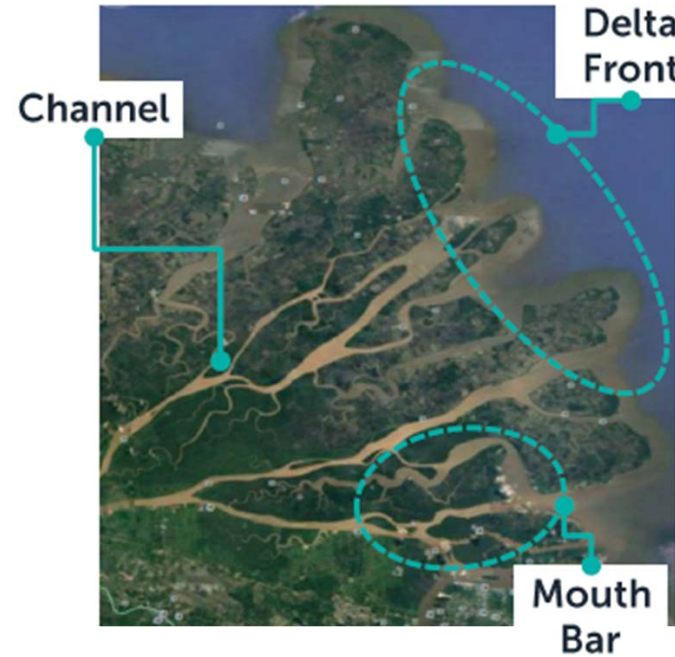
Introduction



- The field development strategy has been driven by water flooding for the past two decades as the secondary drive mechanism.
- However, in recent years, the field experienced significant production decline due to inadequate water injection that warrant immediate mitigation plan and action.

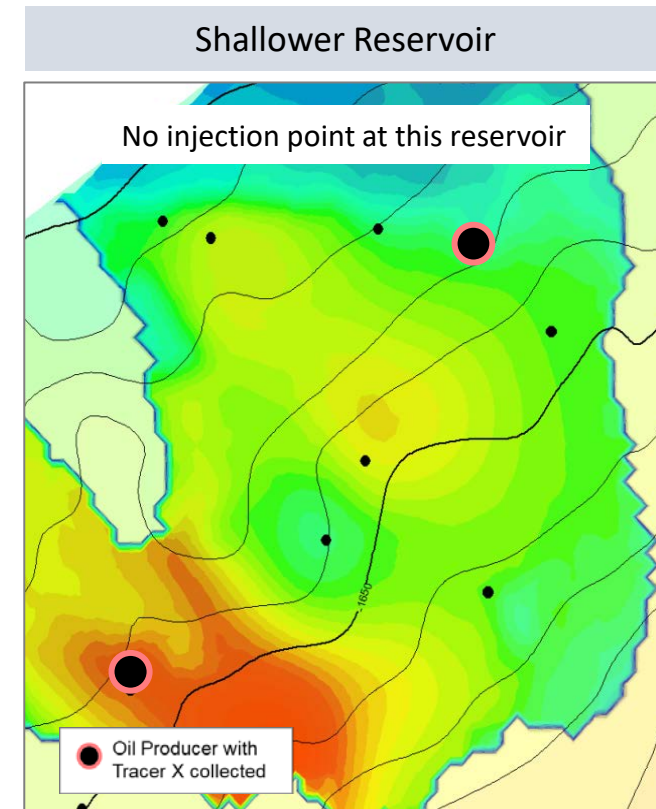
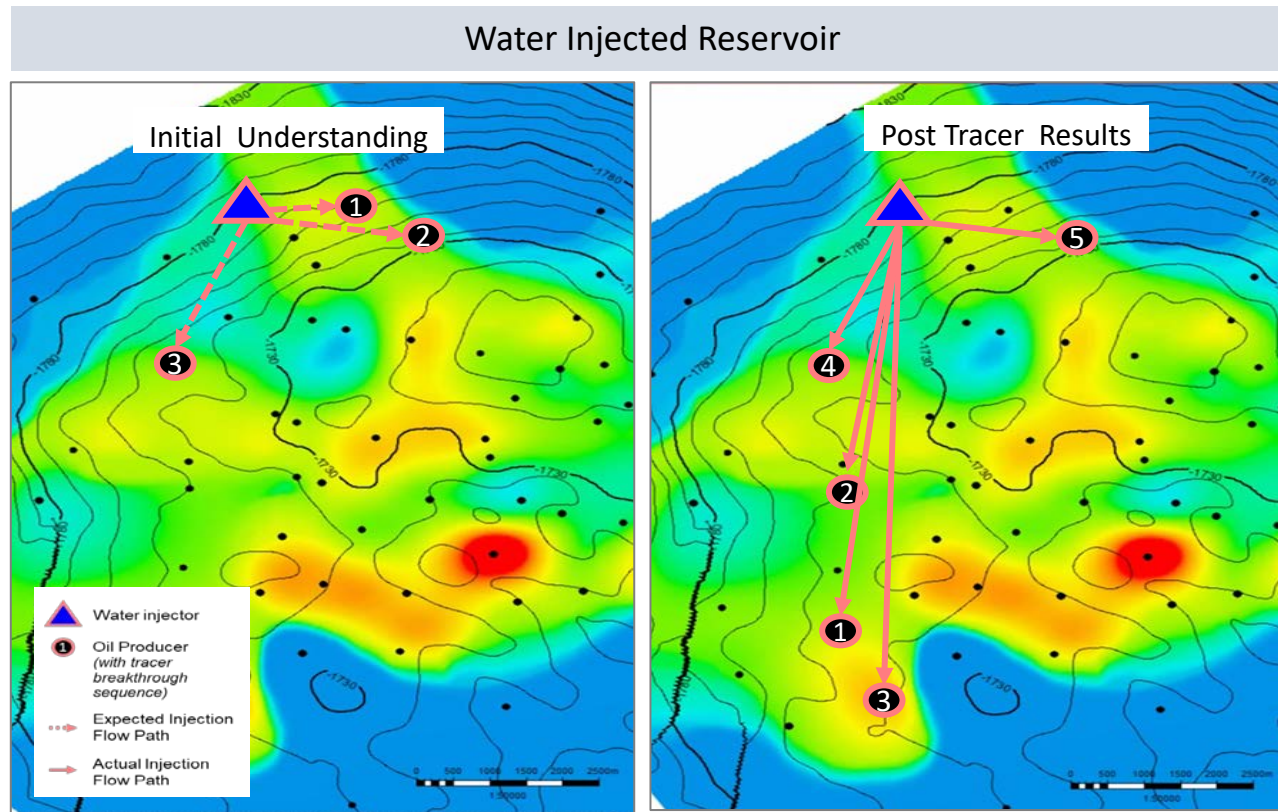
Geological Complexity

- Consists of multi stacked reservoirs deposited in a fluvio-deltaic setting.
- The reservoirs are made up of mouth bar complexes and channel point bars with a combination of structural and stratigraphic hydrocarbon trap.
- Uncertainty in lateral and vertical connectivity of the reservoirs pose challenges in water flooding and reservoir management.



Establishing Flow Communication

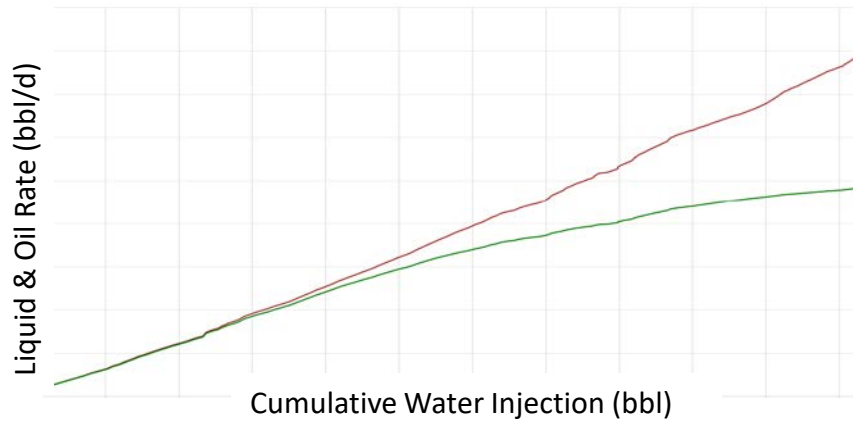
Inter-well injection tracer suggests a new set of producer-injector pairing. The injection flow path and breakthrough time for the tracers do not correlate with the initial understanding.



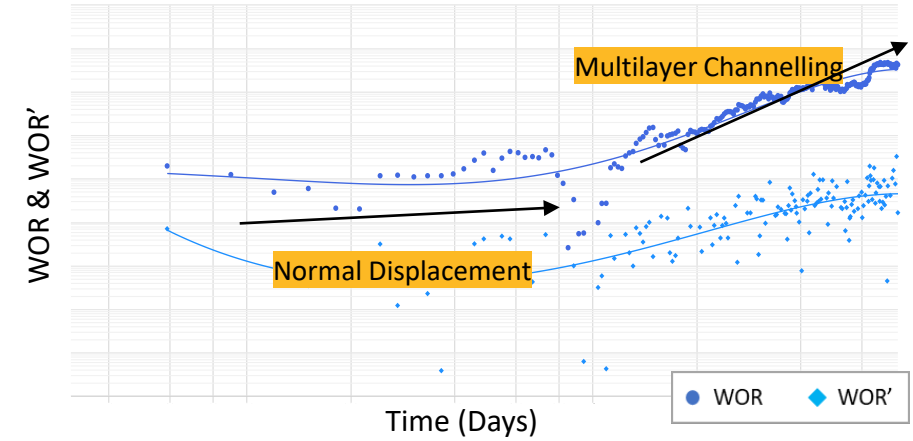
Identifying Optimization Opportunities

Analytical production-injection performance analysis aids in identifying injection optimization opportunities.

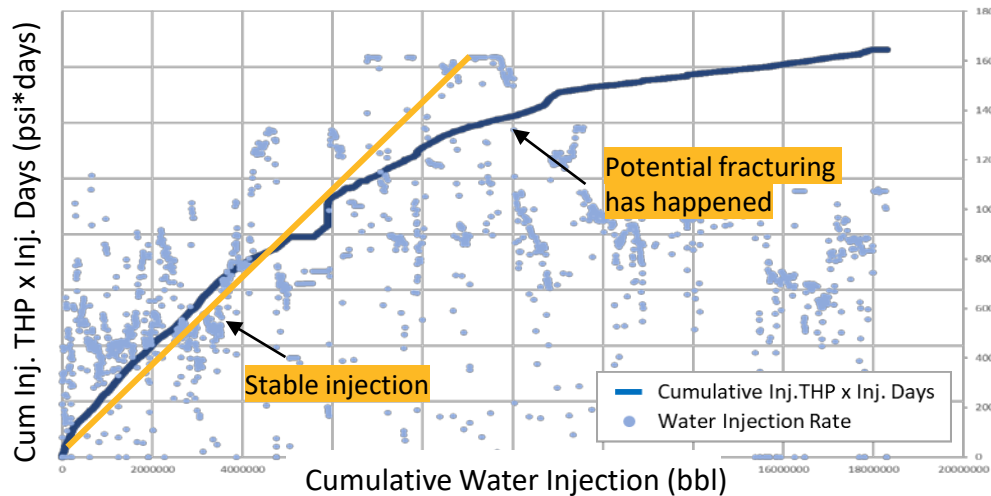
Jordan's Plot



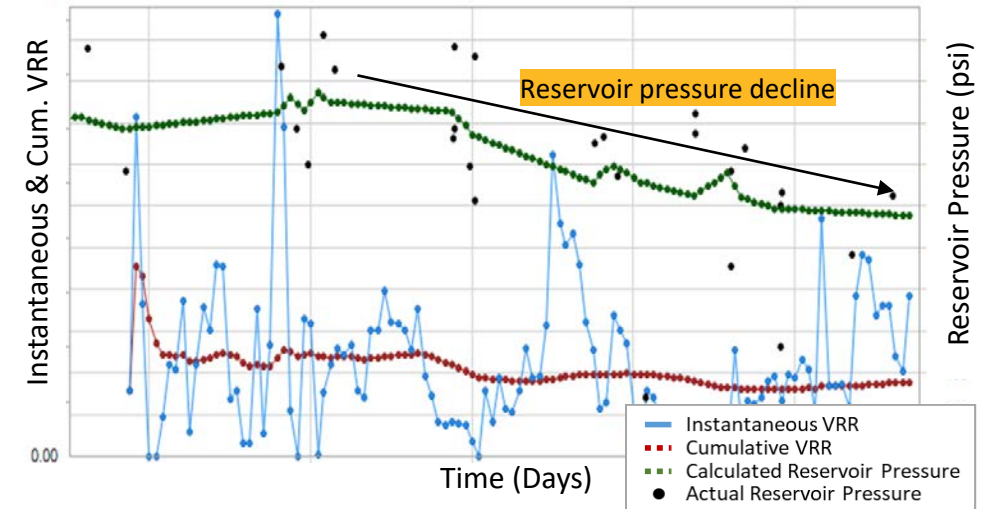
Chan's Plot



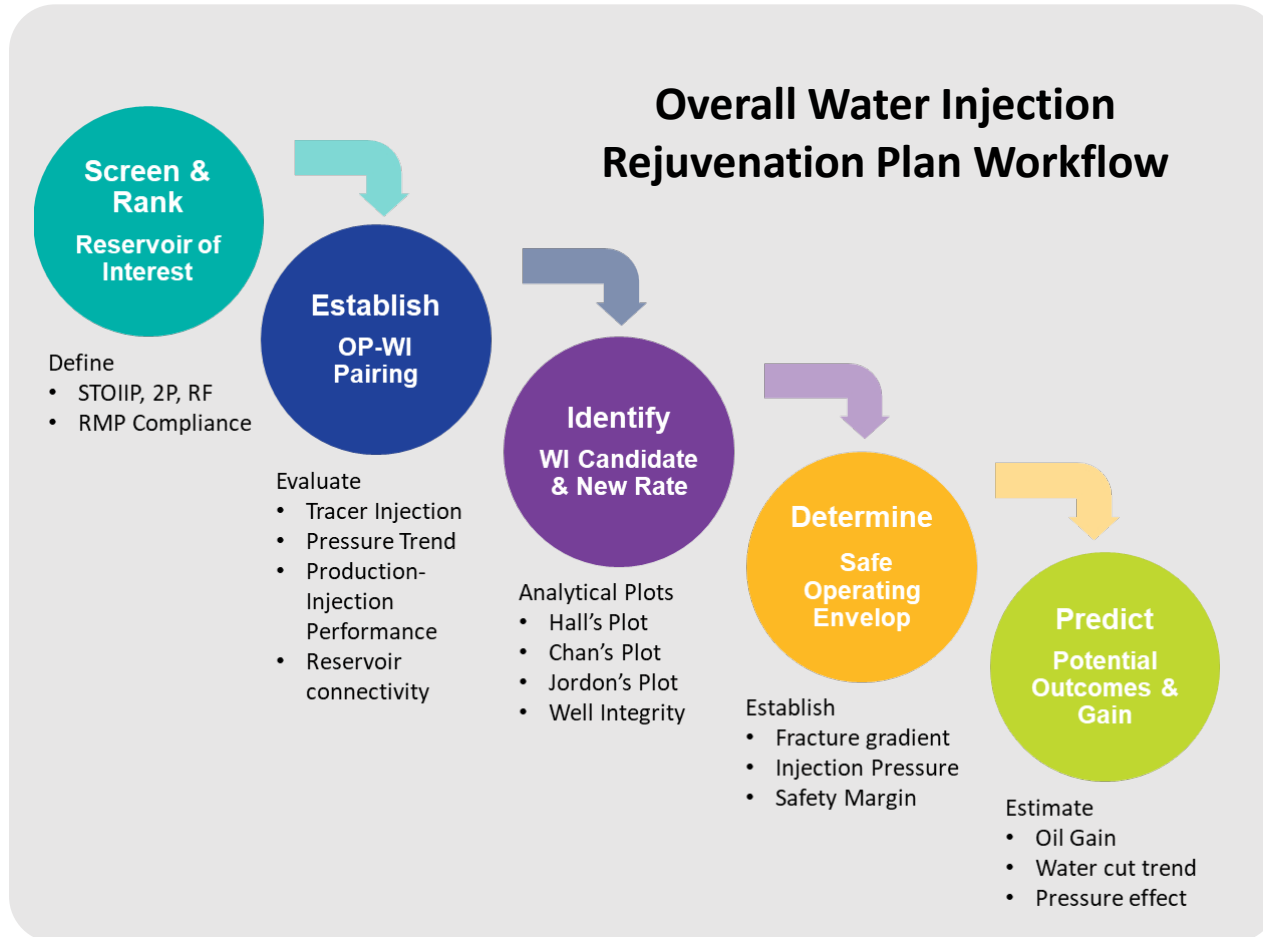
Hall's Plot



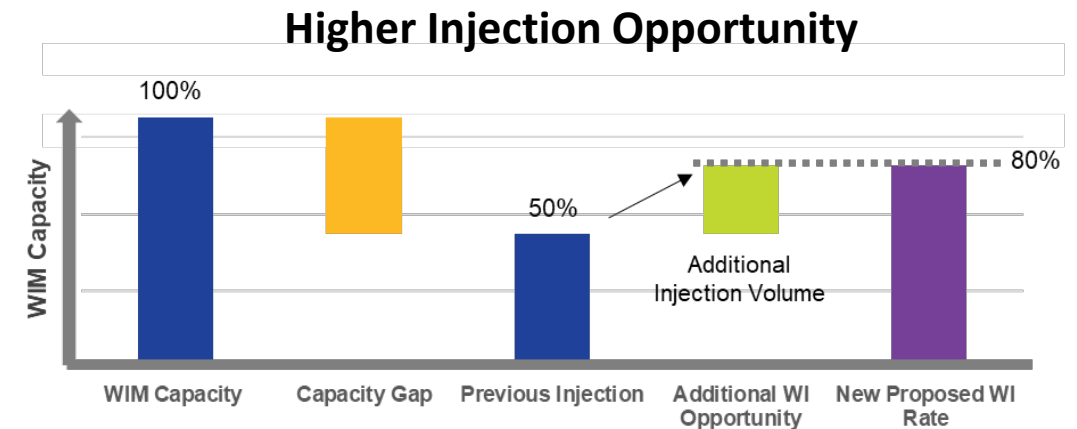
VRR vs Reservoir Pressure



Water Injection Rejuvenation Plan

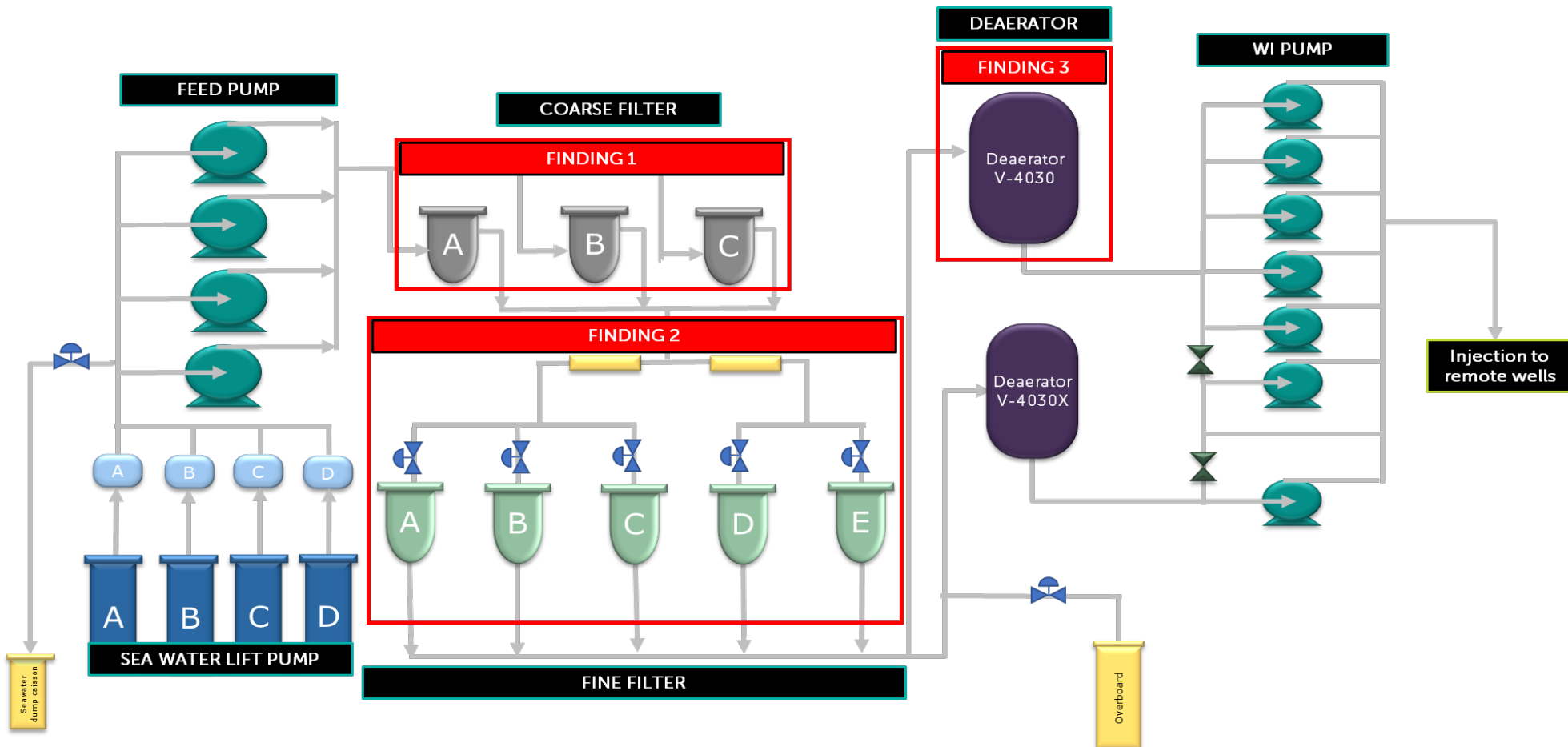


Each reservoir in the field was evaluated, incorporating updated data acquisition and analytical evaluations. The findings were compiled and ranked for execution.



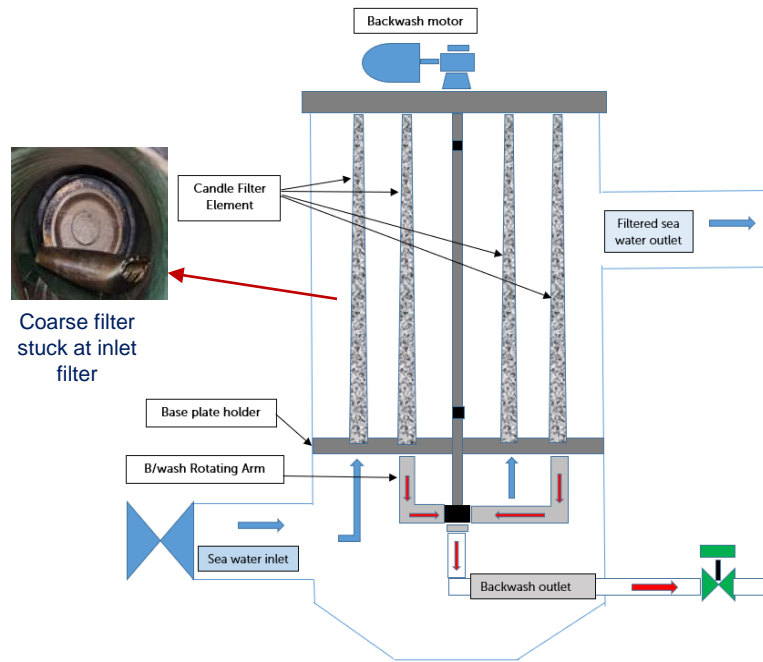
Operational Challenges

A series of operational issues has arisen with the water injection facilities, occurring one after another , hindering from the injection ramp-up.



Operational Challenges

Coarse Filter Candle Parted



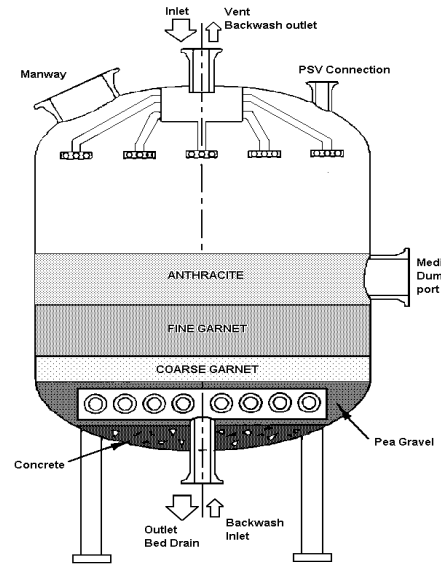
Fine Filter Media Carryover



Fine Filter slope test result (3) with traces of garnet



Mushroom cap installed with Loctite



Deaerator Performance Inefficiency



Deaerator column



Spray nozzle cleaning



Palling stacked

Finding

Candles (filter cartridge) of Coarse Filter parted and stuck at inlet Fine Filter

Action

Performed Radiographic Testing (RT) to identify location of parted candles

Finding

Fine Filter garnet carryover were found during slope test, impacting the water quality

Action

Installed mushroom cap with Loctite and planned for staggered mushroom cap and garnet change

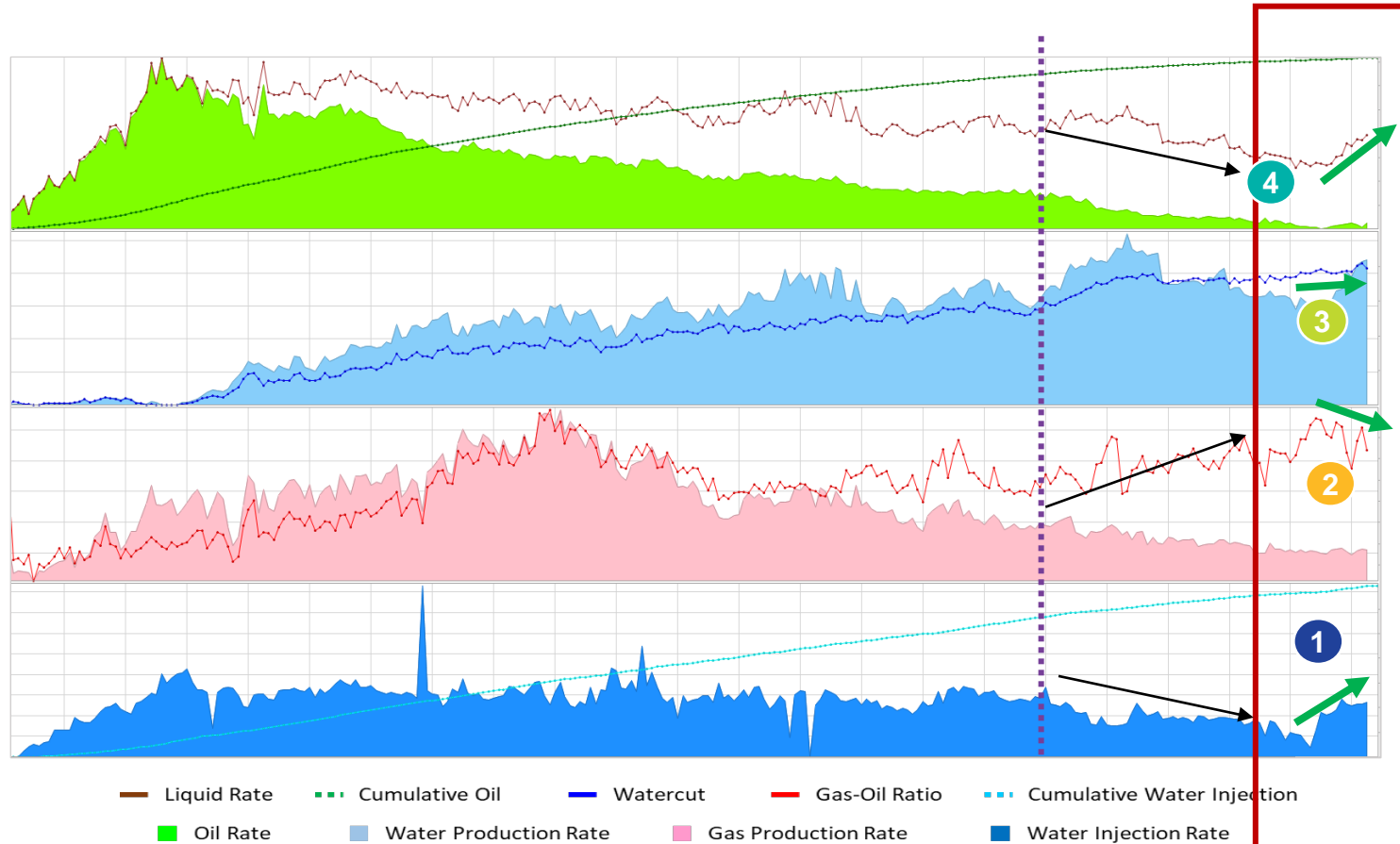
Finding

Inefficiency of deaeration system

Action

WIM Total SD Campaign for internal and external inspection and chemical fine tuning

Field Production Improvement



- Water injection rate has been successfully ramped-up, nearing the initial target rate.
- Close and continuous monitoring of the WIM's healthiness to ensure uptime
- Positive outcomes in field performance have been observed

- 1 Water injection rates have successfully ramped-up.
- 2 Increasing trend of GOR has been tempered.
- 3 Modest rise in water cut.
- 4 Liquid rate level has increased, along with oil production.



Conclusion



- ❑ Understanding of the flood pattern from tracer analysis, along with assessing producer-injection performance assessment and validating well integrity status, is critical to strategically ramping up water injection at the right area in a safely manner.
- ❑ Despite the challenges, effective collaboration among all parties led to a successful water injection ramp up. Proactive efforts and creative solutions by operation team have enabled the implementation and realization of identified opportunities.
- ❑ Current field production performance indicates positive outcomes. The liquid rate has been lifted and restored along with improvement in oil production. The increasing trend of GOR has been reversed with manageable water cut.

