Collaborative Geological-Engineering Integration for Unconventional Reservoir Development

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Integrated Modelling Approach to Calculate Optimum Dewatering Rate in Deeper CBM Wells: Field Implementation from Raniganj Block, India.

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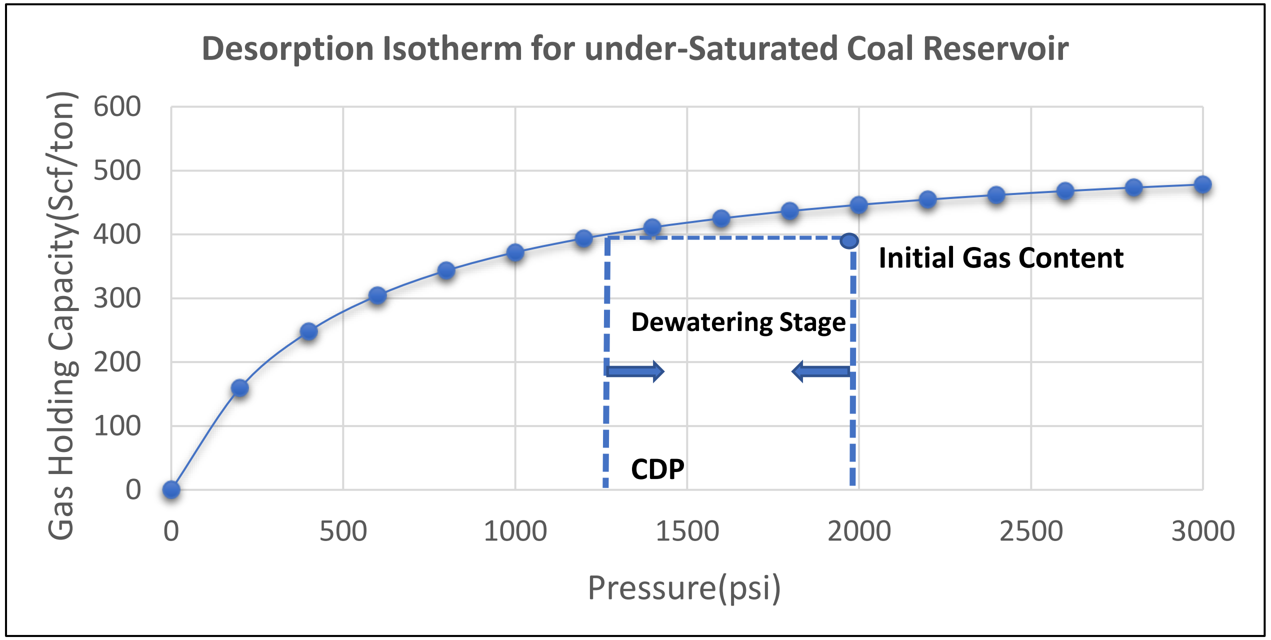
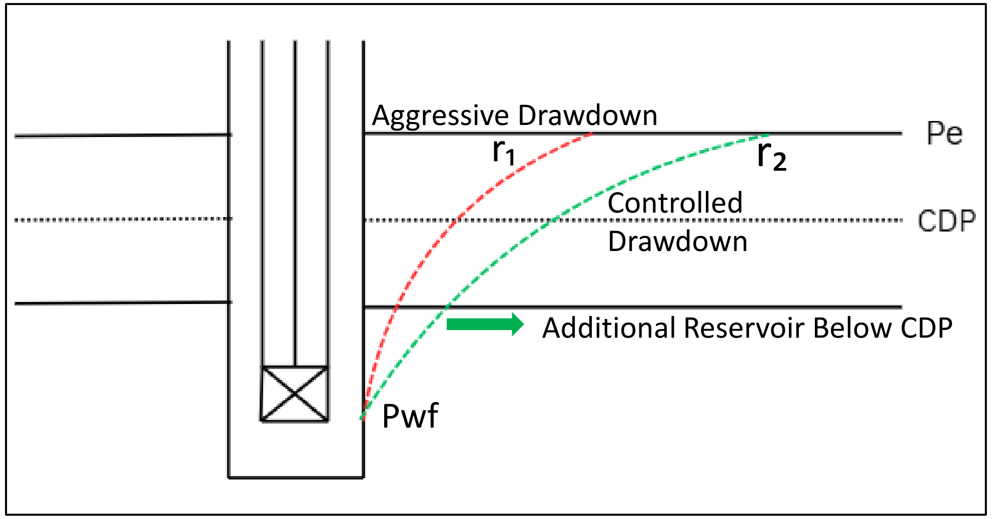
CBM Dewatering Rate Dilemma ?





Dewatering Stage

Transition Phase

Gas Desorption Stage

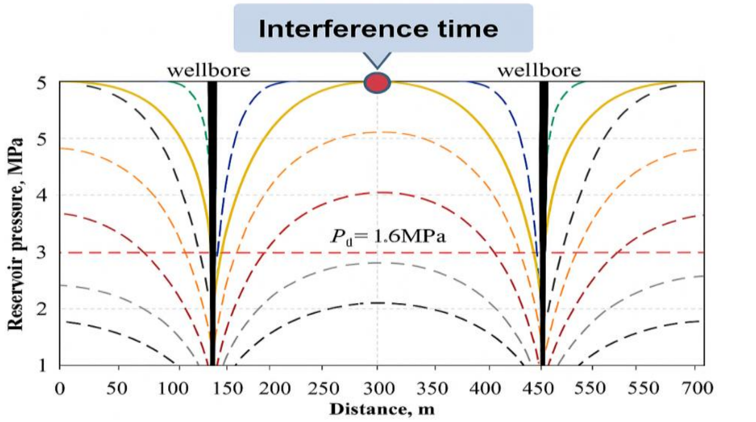
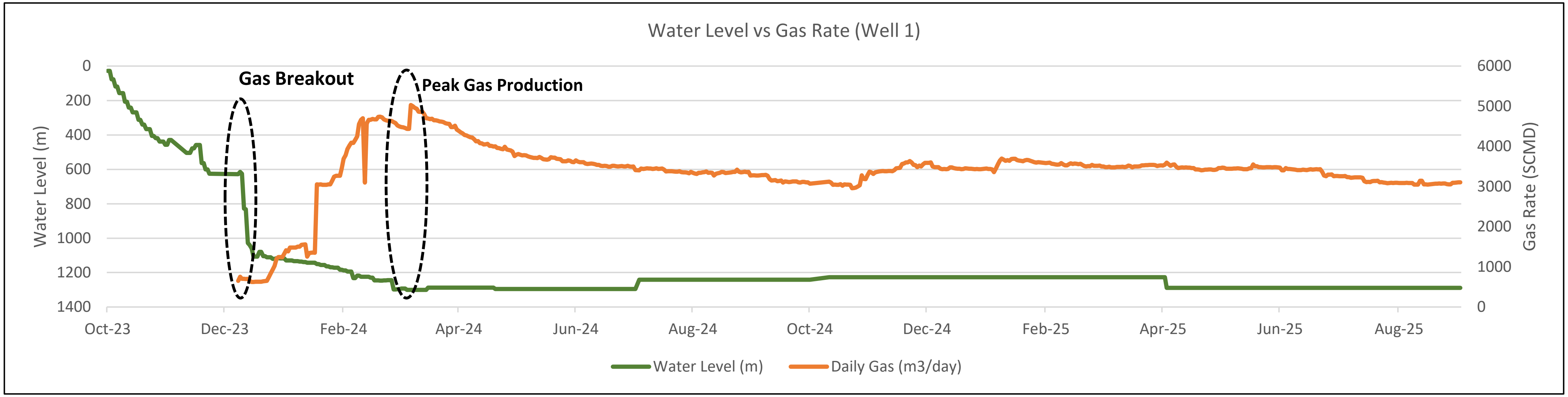
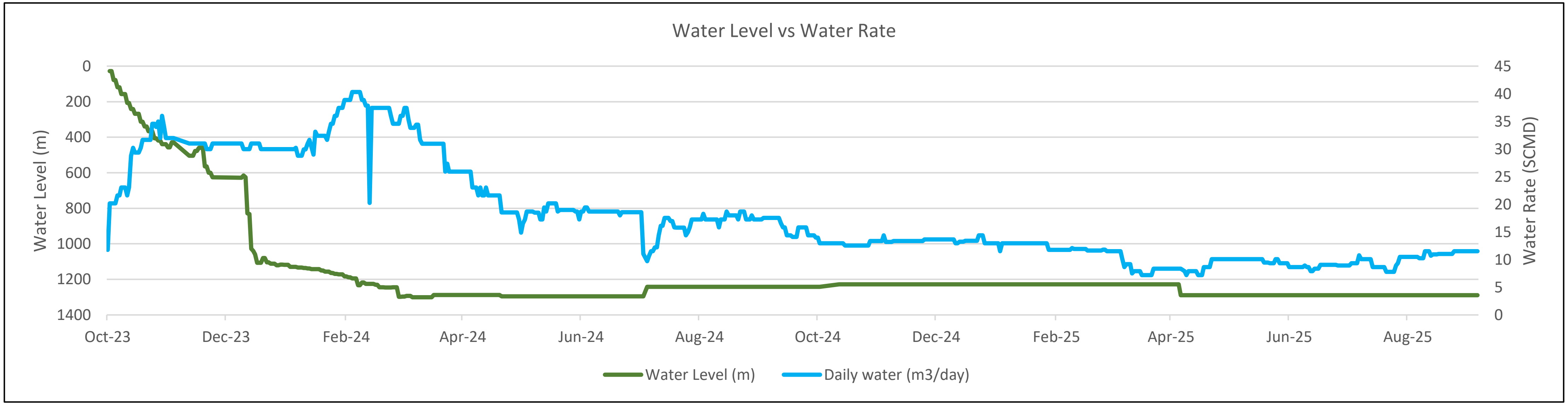


Fig. 6. Schematic diagram of multi-well pressure interference

Traditional Approach and Limitations



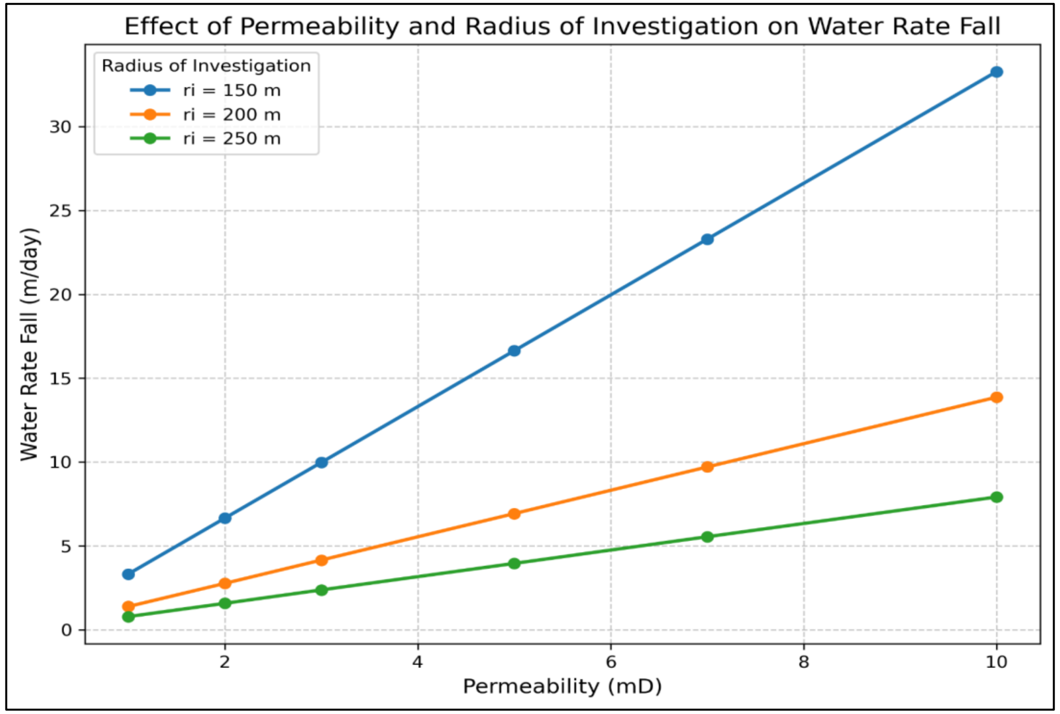


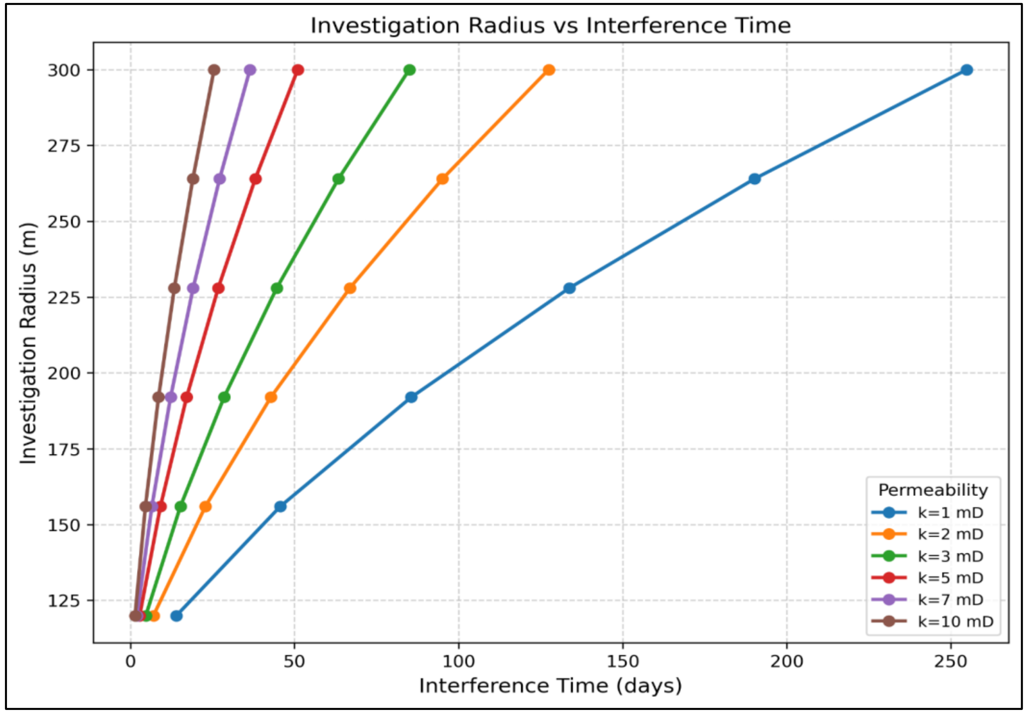
Model 1:- Pressure-Front-Based Drawdown Calculation

$\psi_i = \frac{1}{2} * \ln\left(At + 1 + \sqrt{(At+1)^2 - 1}\right)$ *Where,* $A = \frac{0.6912k}{\phi \mu C_t L f^2}$ & $\psi_i = \cosh^{-1}(r_i/Lf)$, calculated from Geometry

$$\frac{\Delta h_w}{\Delta t} = \frac{1}{\rho_w g} * \frac{\Delta p}{\Delta t}$$

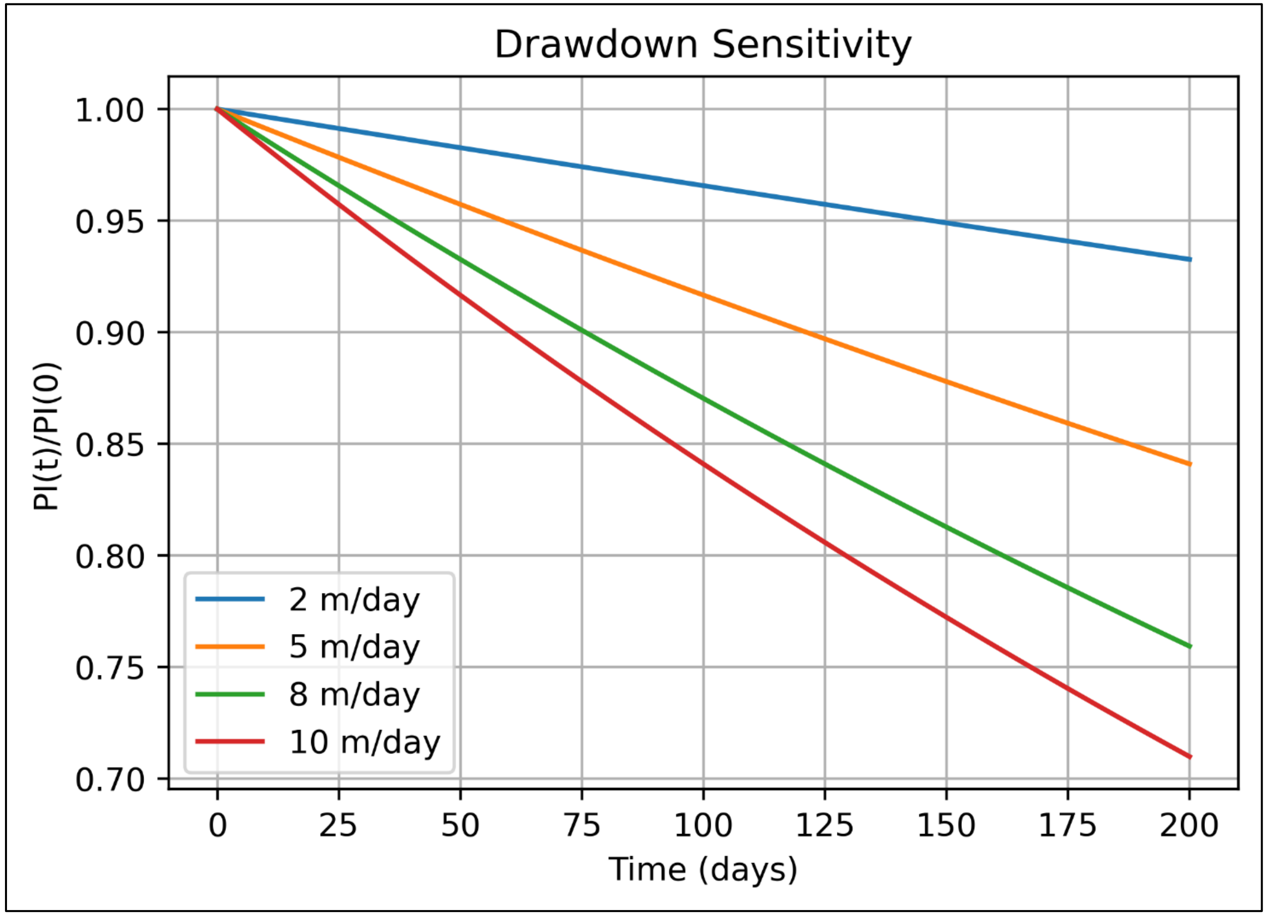
(Source: Xu et al., *Fuel*, 2017)





- ❖ Higher permeability → Shorter Interference Time
- ❖ Larger r_i → Delayed Pressure Interference

Model 2:- PI Sensitivity Analysis for Drawdown Control



$$q = \frac{\frac{1}{3Cf} * kh\left(1 - e^{-3cf(P_e - P_{wf})}\right)}{142.2B\mu\left(\ln\left(\frac{r_e}{r_w}\right) + s\right)} \quad \&$$

$$PI = Q/(Pe - Pwf)$$

- ❖ Higher drawdown causes faster PI decline.
- ❖ Controlled drawdown sustains well deliverability.
- ❖ PI ratio decline slower for higher k

Optimum Dewatering Rate – The Match Point Concept

Define Reservoir Inputs & Drawdown Boundaries

- Interference time calculated using model 1.
- Set the upper limit on drawdown rate.

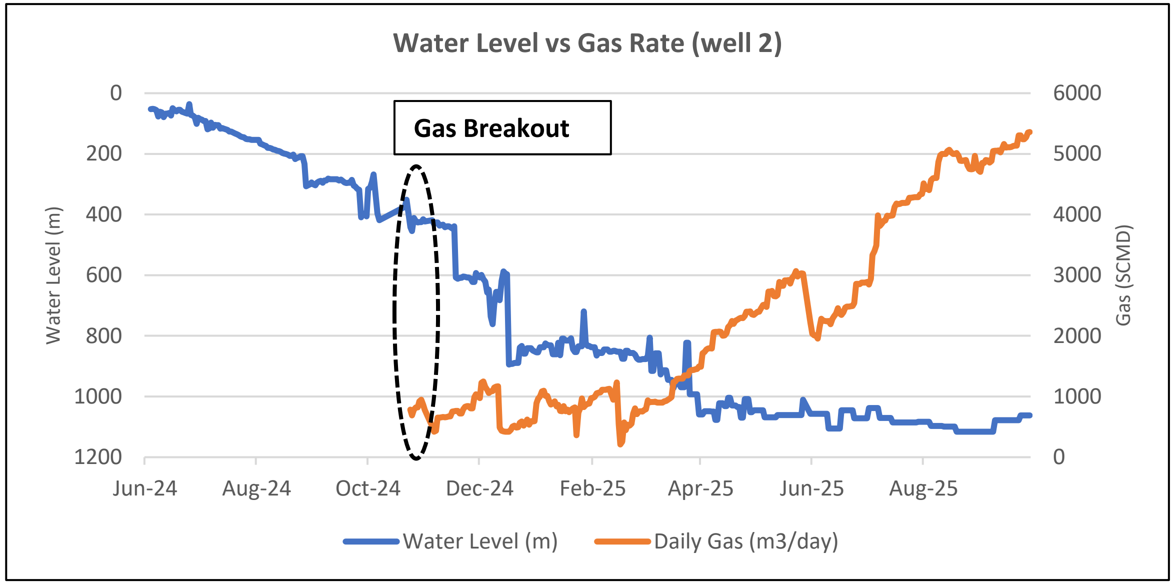
Define Drawdown for safe PI Decline/No Damage.

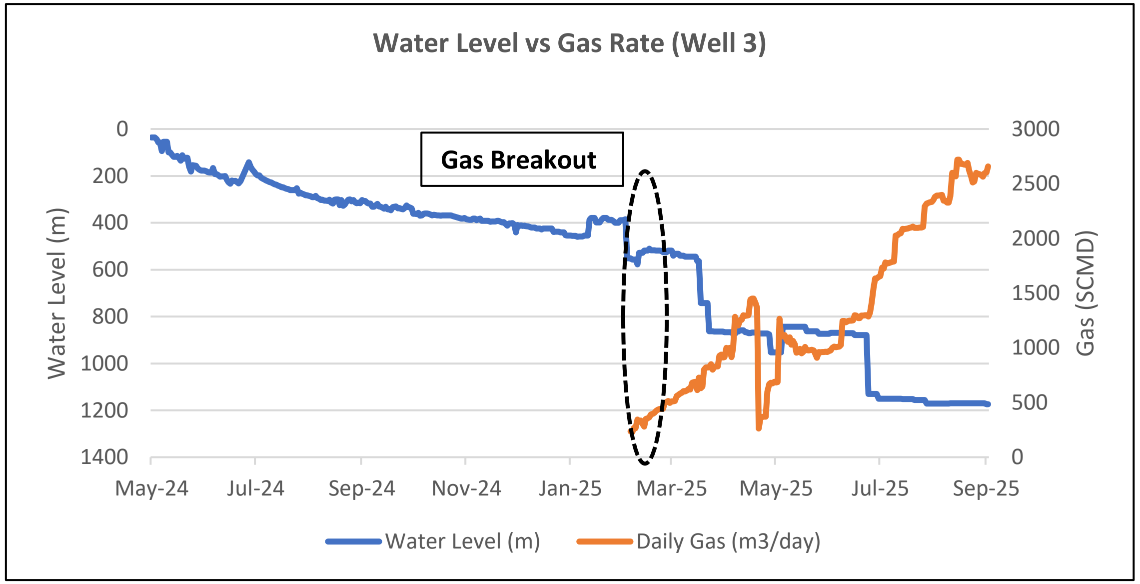
- PI ratio checked at interference time until PI_ratio ≥ safe decline at t_i.
- Obtained optimum drawdown rate.

Result – Optimum Dewatering Rate.

- $(\Delta h/\Delta t)_{opt}$ provides balanced pressure decline and stable PI response.
- Maintain operation for sustainable gas production.

Field Execution & Outcome

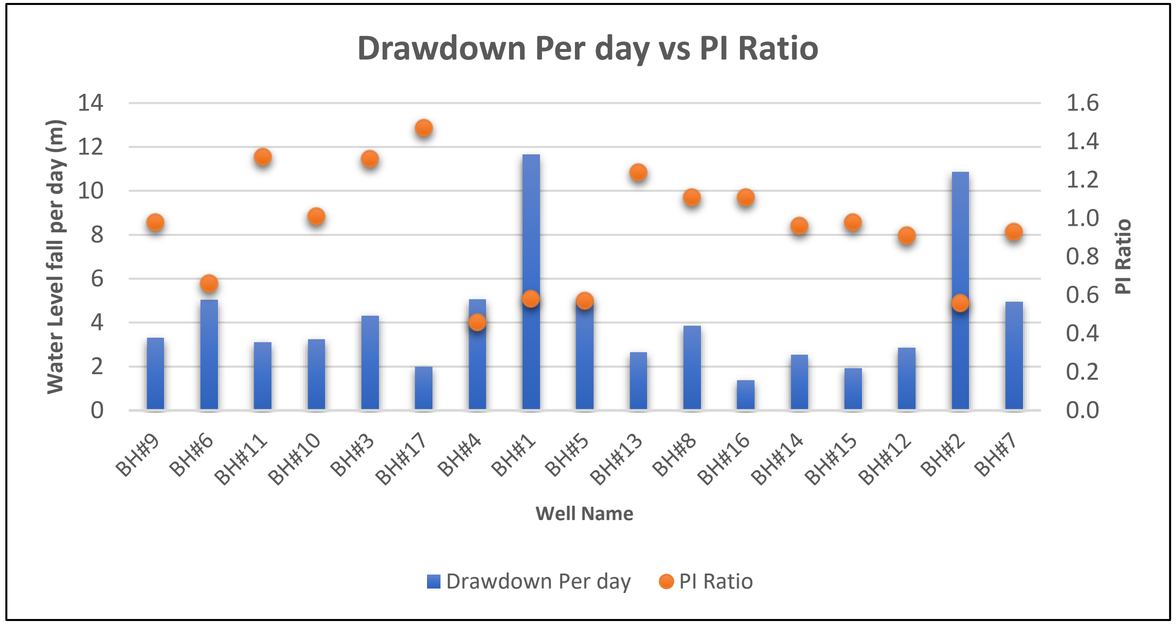


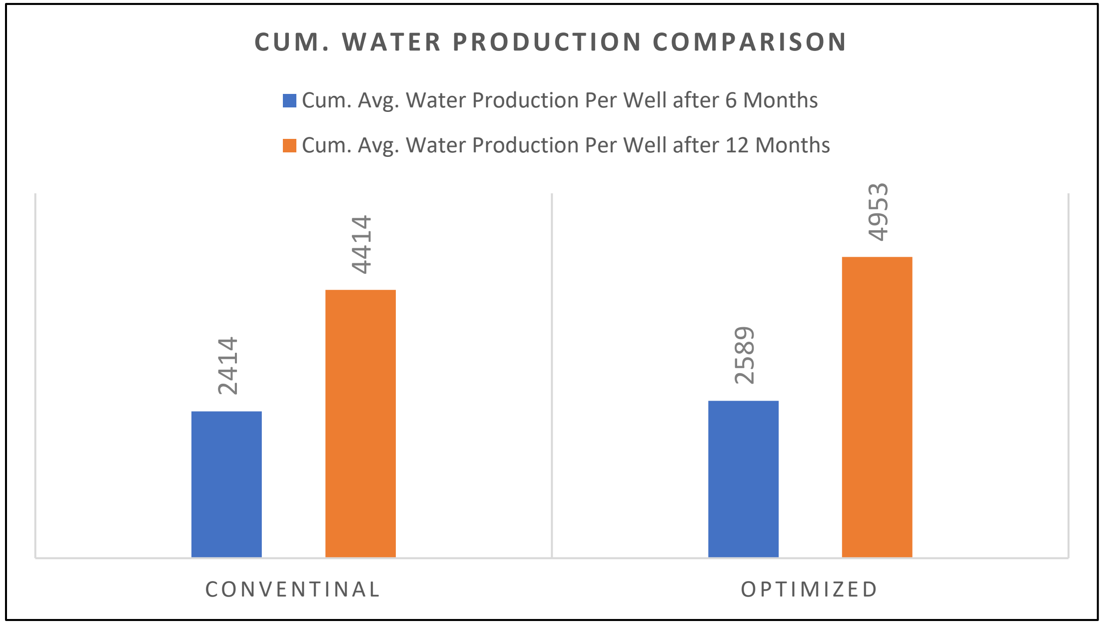


- Controlled drawdown
- Longer De-watering Period
- Higher cumulative and sustained Peak gas Production

- Only top seam exposed.
- Stable gas increase post breakout phase.
- Effective desorption even in top seam.

Controlled Drawdown, Improved Well Performance





❖PI degradation reduced by 40-50%.

❖Greater cumulative water production.

Key Takeaways

❖ Developed Optimized Field Dewatering Strategy

- 40-50% reduction PI Degradation.
- Controlled drawdown sustains productivity.
- Gradual drawdown maintains permeability stability.
- Greater cumulative water production achieved.
- Higher Peak gas rates achieved and sustained.