Rejuvenate Brown Field with the Characteristic of Lenses Reservoirs and Securing New Wells Net Present Value Up by Performing In-House Holistic Study

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Abstract. S-Structure, an area operated by PT PERTAMINA EP, has been producing oil and gas since 1976 and located in Upper Kutai Basin which is famous with lenses reservoir characteristics. Inspite of the challenges S-Structure faced in 2013 until early 2018 where production decline was severe and 5 previous drilled wells were considerably dry, it awoke again by a successful 989-bopd-drill well in 2019. There were two Final Investment Decisions (FID) made to finally effectuate drilling again in S-Field. Nonetheless, the first FID was a concern due two unexpected shale out and unprognosed gas layers and accordingly contributed minus Net Present Value (NPV) and the second FID consisting of 15 new well candidates got cancelled. Therefore, this study was conducted to tackle this hesitation. Subsequent to implemented method, we got approval for the 2nd FID. The analysis was safely done without incidents and secure 15 wells to still be viable to drill. We divided S-Structure into sectors of Graben, West Panel, and East Panel which have their own behaviors, properties and productivity and we set minimum distances over offset wells afterwards. Within almost a year there were 5 new wells POP-ed with the total NPV and reserves realization are USD 7.58 million and 483 thousand stock tank barrels oil respectively. The method implemented is thorough and well suited with small tanks in such S-Strcuture. The result somehow creates positivity and encouragement to all members to stay striving towards profitable and efficient development strategy. New well proposals are designed through static and dynamic model generally speaking. However, it has always been a different approach when it comes to lenses reservoir type. There are plethora of costly methods to reduce subsurface uncertainties, yet during the time of the field is considered marginal, efficiency is the most profound and considerable action. Therefore, this method was developed consistently in-house with almost zero investment budget.

Keyword(s): Lenses, new well, FID, back-allocation, new pool, portfolio, challenge-session, NPV, less-risk.

1 Background and Objectives

1.1 Structure Overview

S-Structure is located in Northeast-Southwest Anticline Structure in Northern Upper Kutai Basin. Sands were mostly deposited in transitional and deltaic environmental (delta plain – delta front) accumulated in stratigraphical and structural traps. From 1930, when a development well was put on production to recent drilling process, S-Structure has been friendly due to less drilling hazards. All prolific layers in S-Structure are still in hydrostatic regime, therefore it does not need any more weighting agent that can cause severe damages to formation.

In the current thriving process of S-Structure, there are 5 main development areas of S-Structure which are Flank, Crestal, Graben, Stepout, and Deep Zone. The fact that S-Structure consists of many lenses reservoirs and separated by seemingly sealing faults conveys that there has to be various ways to strive towards persistent oil and gas production[1]. Looking at subsurface prominent driving mechanisms are dominantly contributed by solution gas drive and partly contributed by water drive.
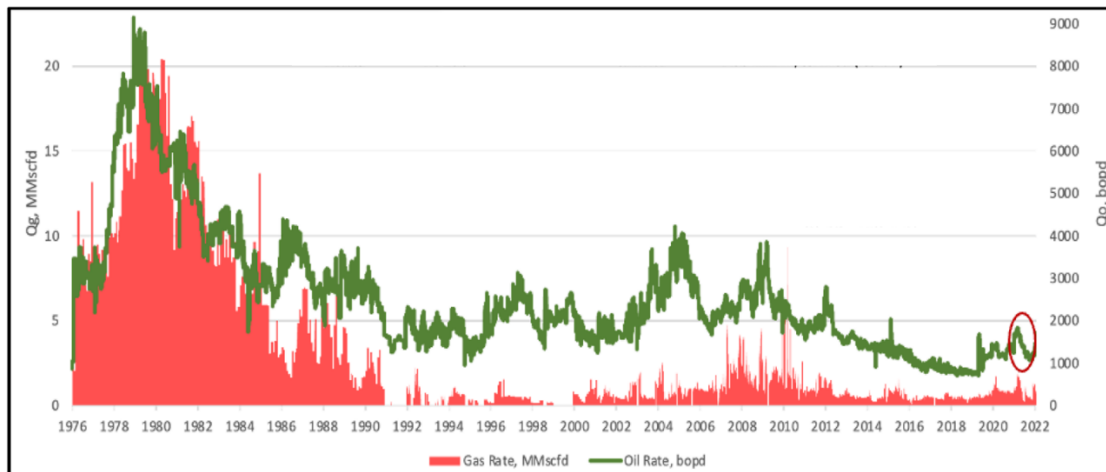
1.2 Background

Figure 1 Historical Production of S-Structure

After producing for almost a century, only 32% of the total wells that are currently producing. This is due to small tanks and rapid production decline. Furthermore, wells are already tight-spread over the area. These what really challenge the development of S-Structure. Subsequently, in early 2021, S-Structure faced more hardships, the trend production decline went severe as shown in Figure 1 with red circle. There must have been massive drilling and workover programs to sustain the production. However, there are a couple of highlighted points in the previous drilling programs such as:

- The proposal booked reserves per group not per sand. This resulted less predictive and accurate proposal.
- The process of reserves calculation was still based on commingle-layers production data, therefore there still were huge uncertainties on well references.

To overcome this rapid production decline, the Plan of Further Development Plan (POFD) for S-Structure has been ongoing and divided into several phases. Phase one result was satisfying enough to propose another phase which consists of 15 drilling well proposals. In early quarter of 2021, all these wells were approved internally and externally.

1.3 Problem Statement

However, during the declining production of S-Structure, there were other doubled-shock: three infill wells in a row were not achieving targets as shown in Figure 2. Those three undesired drilling well performances contribute oil rate far below target of 200 barrels oil per day. This was an unexpectedly distressing news for management. Further management review there has to be an action done to hamper this unprofitability development strategy. Efficiency was the target, the drilling budget should accordingly be allocated to other productive structures.
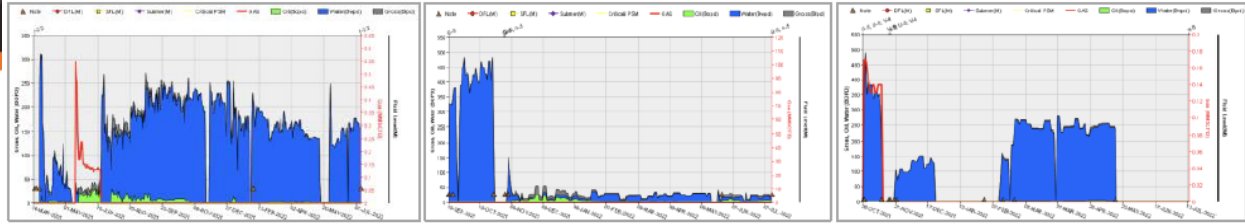
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Figure 2 Three Unexpected Drilling Wells Performance

In the last quarter of 2021, management finally ordained a decision to postpone all upcoming drilling wells in 2022. This was going to risk the whole oil production potential from 15 approved drilling wells which equals to 3,000 bopd Qoi (Initial Oil Rate) and 14.3 million dollars NPV (Net Present Value). To prevent that end, there has to be a method to convince the existence of oil potential in S-Structure.

2   Strategic Planning and Execution

2.1   Determining Alternative Solution

From the problem, it clearly can be seen that there should be a method to revalidate the oil potential in S-Structure. Based on the Cost and Benefit Analysis in Table 1 considering planning duration, project cost, safety risk, and external manpower needed, alternative 3: In-House Modelling must be suitable to ensure oil and gas potential in S-Structure in a short period of time.

Table 1. Cost and Benefit Analysis

Parameter	Case		
	Alternative 1: Geomodel Study	Alternative 2: Passive Seismic Acquisition	Alternative 3: In-House Re-modelling
Planning duration	> 1 year	> 1 year	4 months In-house study
Cost (kUSD)	566	100	
Safety Risk	Low	Medium	Low
External Manpower Needed (person)	4	10	0

2.2   Workflow Process

This in-house remodelling study includes 4 main steps which are:
1. **Analysis the performance of three recent unexpected drilling well results**. There are S-X01, S-X02 and S-X03 as shown in Figure 2. The results denote that actual layers are depleted target, reservoir properties lesser, and operational issues that caused damages and unwanted event.
2. **Revisit all drilling wells from the last 9 years**. After analysing 3 most recent drilling wells, a deep look and analysis was conducted too to see wider helicopter view regarding oil and gas potential in S-Structure. From the analysis, it is vivid that all contributions are coming from *new pool* layers as pictured in Figure 3, which are isolated and never been produced before, thus the pressure still virgin around 0.95-1.05 SG equivalent. Therefore, the strategy for the next drilling targeting this kind of layers.
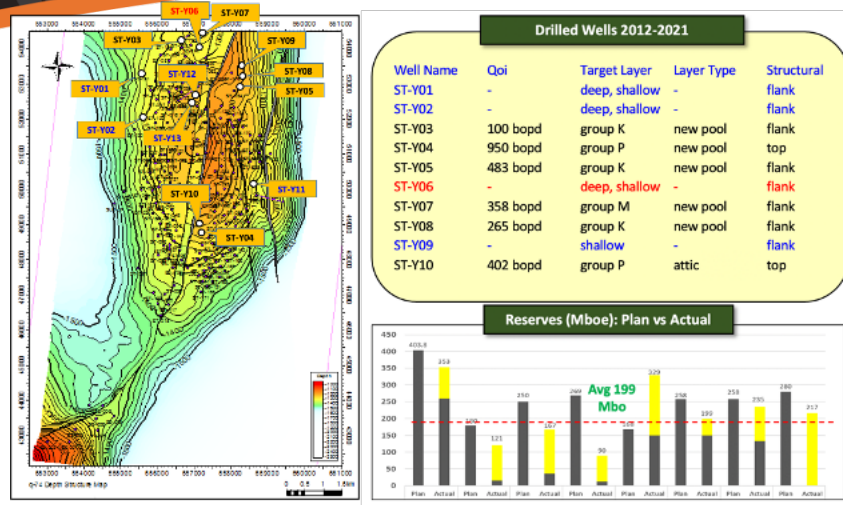
Figure 3 Recap of drilling results from 2012 to 2021

3. **Study new pool using deterministic approach**. Most of the producing wells are commingle. Commingling of hydrocarbon from difference producing sources or streams into a shared production or transportation facilities offer a significant cost savings advantage[2]. This strategy is common in lenses reservoirs. However, it could be a challenge regarding the production allocation for each layer. This method then conducted detailed back allocation to all production data. In the final end, there are distribution of thickness, distance among wells, and dimension of new pool as shown in Figure 4 that would be the guidance of proposing next drilling wells. Lesser than 250 m distance with offset wells would be okay if it refers to the width to thickness (point bar dimension) analysis.

4. **Building development portfolio.** From all evaluations effectuated, it can be seen that the potential and opportunity to develop S-Structure do still exist. Sandy back-filled distributary successions are somewhat thinner and closer together in the upper delta plain than in the lower delta plain[3].The development has to aim to new pool layers. Since then, the team built a portfolio and that would be the tool to convince stakeholders. The portfolio objects to 5 different development areas which are:
   ➢ Flank area: targeting the most outer of a structural reservoir
   ➢ Attic/crestal area: aiming to the most top or updip from an anticline
   ➢ Graben area: objecting to the area where surrounded by faults
   ➢ Stepout: this means to unlock and unleash other potential areas within S-Structure that has least well references.
   ➢ Deep zone: targeting deep layers (>1300 mTVD) to unlock other productive zones besides current producing layers.
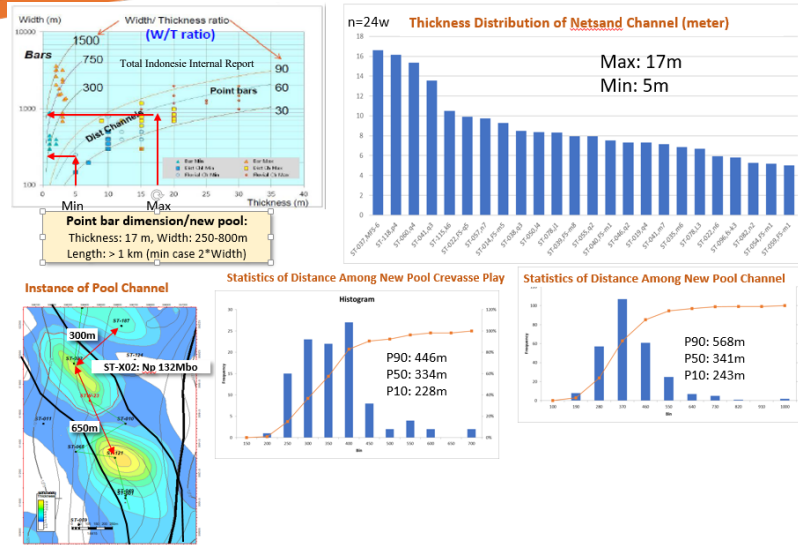
Figure 4 Study New Pool in S-Structure

3   Results and Monitoring

3.1   Net Present Value

In the end of 2021, the result was introduced to stakeholders and they reapproved 15 drilling proposals including 2 additional wells utilizing this tool covered in 2nd phase of Development Plan. Until this August 2022, there are already 5 wells have been POP-ed contributing to Net Present Value (NPV) of $7.58 million and 11 drilling proposals approved that are going to be drilled in the remaining 2022 and in the upcoming 2023 contributing $7.78 million NPV. Totally, this contributes $14.28 million. This can be seen in Figure 5.
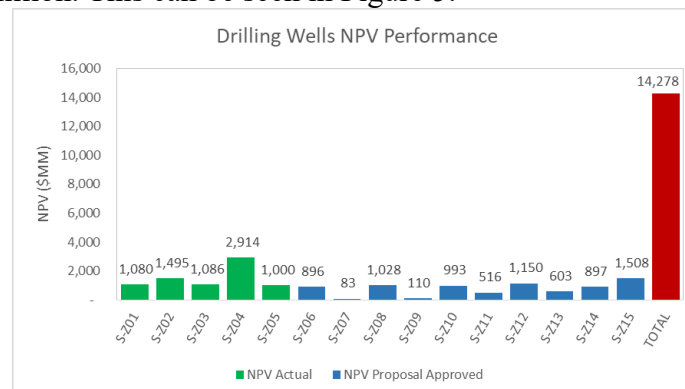

Figure 5 Net Present Value from Drilling Wells That Have Been Produced and Wells That Are Going to be Drilled

3.2   Oil Production

Other than that, 5 wells that have been producing sustainably and prevent rapid decline from baseline production as imaged in Figure 6. This simply shows that lenses reservoir should be treated by different strategy to cope with huge declining rate.
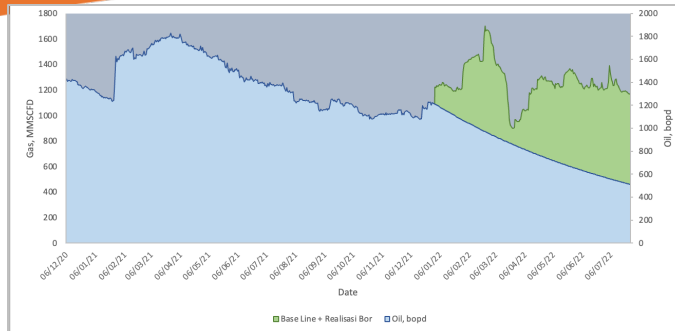
Figure 6 Baseline vs Realization of Production Performance of S-Strutucre

New well proposals are designed through static and dynamic model generally speaking. However, it has always been a different approach when it comes to lenses reservoir type. There are plethora of costly methods to reduce subsurface uncertainties, yet during the time of the field is considered marginal, efficiency is the most profound and considerable action. Therefore, this method was developed consistently in-house with almost zero investment budget.

4   Conclusion

As the study has been done in S-Structure, dominantly lenses reservoir play, there are key takeaways that can be inferred such as:

- Based on the result, the method to build development drilling portfolio is highly recommend in the lenses reservoir. The further drilling development will eventually utilize the portfolio that has been built.
- The process done reassured stakeholders to approve reproposed 15 postponed drilling wells that already contribute real NPV $7.58 million from 5 post drill wells and $14.3 million in total. Also, the post drill wells are producing and leveraging production S-Structure up to 1,600 bopd.
- There are 5 wells have already been producing in 2022 and achieved 86% target Qoi. Other 11 wells are ongoing preparation to be drilled in the remaining 2022 until 2023.

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