

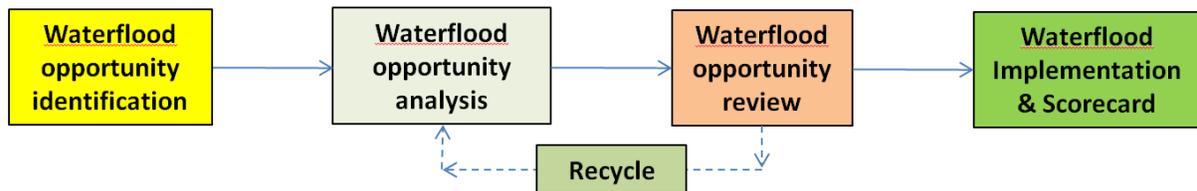
## ***Innovative Approach Maximizes Value from GoT Waterfloods***

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### **Innovation Feature:**

The waterflood opportunities in our asset, which is located in the Gulf of Thailand, are distributed in a large number of small to medium size reservoirs. The oil reservoirs are mainly fluvial in nature with pay sands that can exceed 10 per well. The geological complexity has created a large number of opportunities distributed in a random way.

Earth Scientists, Reservoir and Petroleum Engineers regularly identify potential waterfloods from current platforms which are fed into the waterflood opportunity list. This list has more than 600 possible waterflood reservoirs and over 2000 well penetrations. An efficient analysis and implementation workflow are required to support the asset waterflood development objectives. The workflow in figure 1 has been developed to improve waterflood management.



**Figure 1** waterflood management workflow

The use of surveillance, analysis and optimization (SA&O) tools on waterfloods provides easy access and functionalities to monitor well performance, review engineering analytical plots and track base waterflood performance. The application was developed using a dynamic report and plotting tool to optimize visualization and interaction with databases.

To improve the waterflood analysis workflow the Integrated Engineering tool is used. The tool provides flexibility to create a large number of allocation scenarios, forecasts, mapping and volumetric calculations. This allows the cross functional team to effectively generate quality outputs for the Waterflood review meeting using a consistent template and process during the Waterflood reviews.

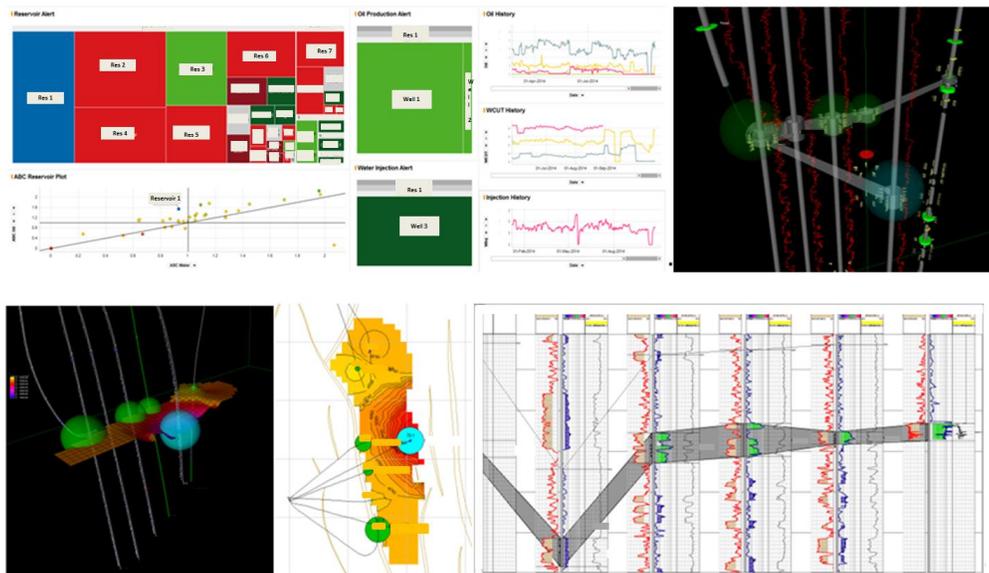
The Waterflood review template includes necessary information for the Waterflood review, taking into account the earth science, petroleum and reservoir engineering aspects. A variety of plots were selected to be presented in the review, including seismic Xsections, production, injection, pressure plots and geochemical data for reservoir continuity and connectivity analysis. Also the reservoir properties needed for a thorough analysis, and plots and tables were standardized to provide a consistent format. Key messages, meeting objectives and clear expectations regarding decisions required helped to improve the number of opportunities analyzed with limited time. The results from the meeting are adopted to manage the waterflood planning list as well as implementation plan and operational considerations.

## Thailand E&P Industry impact and values

The need for multidisciplinary, action driven reviews resulting in high quality decisions and fit for purpose analyses pushed us to create a waterflood review workflow. This has markedly improved confidence in meeting outcomes. Since the implementation of the waterflood workflow, over 80 reservoir characterizations have been performed during 2014. Additionally over 70 waterflood projects have been implemented over the life of the asset, and this helps manage primary oil production decline. Currently more than 30% of the oil production in the asset is associated with waterfloods.

This effective systematic process helps not only develop value adding waterflood projects but also provides basic guidance for new engineers that are included on the team. The workflow proved to be efficient providing quick but careful SA&O information immersion and tangible results in the project queue.

New live tools provide fast response time in terms of evaluation and optimization. Specially designed waterflood tools like the Integrated Engineering application are effective at fully integrating geology, completions, operations and reservoir activities (see Figure 2). The uses of these tools is complimented by reservoir modeling and fit for purpose simulation if needed.



**Figure 2.** New integrated application for waterflood analysis in Thailand

The recycling process after every weekly waterflood review improves the waterflood opportunity list by helping to high-grade value adding projects (see Figure 1). The use of scorecards, integrated with the Team's plans and activities, help to implement the identified opportunities and track the work required to start water injection.

Decision makers find benefits from the workflow due to the well-organized sequence of events. Additionally less experienced petroleum engineers can support the analyses required for identifying,

planning and executing a waterflood while improving their operational capabilities, impact and technical growth.

### **Why this project should win the award**

People are the main driver to success, and as a team it is important to work effectively in an integrated way when faced with uncertainties and risks. The highly complex reservoir types, and large number of opportunities, make it challenging to evaluate and prioritize all the prospective waterfloods. This organized and systematic approach developed for evaluating the waterflood opportunities helps the asset team identify the most impactful projects. This effort supports the need to improve recovery factors in depletion drive reservoirs to ensure efficient and economic recovery of reserves.

Waterflooding in the asset has proved to have a high impact on reserves and given the maturity of the asset more projects are required to support the waterflood base production. As the asset matures opportunities are more challenging to identify and implement due to reservoir and wellbore complexity and depletion level. New integrated tools provide options to effectively analyze all the data and support decisions.

This fine-tuned technical process helps everyone on the team interact in a more efficient way, providing opportunities for both the young and more experienced technical professionals to learn and grow during the 3 hour-weekly review.

The training of new engineers with the best available processes and tools for waterflood evaluation is a business objective that results in producing high impact engineers and can accelerate competency development. The detailed waterflood review workflow enables on-the-job training and exposure on a weekly basis to the technical work required to identify and progress waterflood opportunities. The exposure to the multidiscipline team, including managers, helps provide less experienced engineers a better understanding of what is required to gain support for a waterflood project. The investment in people to improve Organizational Capability is a key objective that will lead to more barrels in the tank in years to come.

The process described here was the result of a need; the need to actively pursue a high number complex waterflood opportunities. This workflow enables the team to focus on the technical work required to make good decisions instead of time consuming data mining activity. Furthermore the workflow provides a methodology to the less experienced task force that demonstrates a simple and effective way to pursue an objective that requires implementation of successful waterflood projects.