# 2014 e-SAGD Year-End Summary

## Introduction

Following the cessation of solvent injection in late 2013, the primary focus for the Surmont e-SAGD pilot in 2014 was on monitoring and analyzing pilot performance during the post-injection period. Solvent returns continued throughout 2014, although at a lower rate than expected based on reservoir simulations and analog pilots by other operators. As of year-end 2014, the cumulative solvent recoveries from well pairs 101-08 and 101-10 were 33% and 39% respectively. Additionally, a detailed assessment of pilot data was completed in 2014 to calculate the amount of solvent returned from wellpair 101-09, which is adjacent to the e-SAGD wellpair 101-08 and which had been producing detectible amounts of solvent since July 2013. This assessment revealed that between 6% and 10% of the solvent volumes injected into 101-08 have been produced from 101-09. While solvent continues to be produced, rates are low and are expected to remain so.

## Solvent Return Analysis and Mechanistic Study

A significant amount of effort in 2014 was dedicated to understanding reservoir mechanisms that contribute to solvent material balance. A qualitative mechanistic study was completed March 2014, the results of which informed a two-dimensional history matched pilot simulation model that was completed August 2014. This model was used to estimate the relative contributions of several possible mechanisms thought to contribute to low solvent production from the pilot. While uncertainty will always exist in any allocation based on simulation, an improved understanding of solvent retention in the e-SAGD pilot wells and solvent movement to adjacent wellpairs was achieved. Within the pilot wells, it was determined that a significant amount of injected solvent could remain in the reservoir due to high subcool operation, reservoir heterogeneity, thermal interactions from adjacent wells and injection of solvent into mature steam chambers, whereas solvent transport away from the e-SAGD wells could occur following coalescence with adjacent steam chambers.

## Interpretation of Seismic and Observation Well Logs

Two additional 3D seismic monitors were completed in 2014, which have provided new insight into the impact of solvent injection on steam chamber development. From interpretation of these seismic shots, it was confirmed that solvent injection accelerates lateral steam chamber growth compared to conventional SAGD. This creates a potential opportunity for well spacing optimization in a commercial e-SAGD implementation that is different from optimal SAGD well spacing.

Valuable information was also gained through the interpretation of reservoir saturation tool (RST) logs run in certain observation wells in early 2014. It was observed that lighter solvent components in the gaseous phase may be able to travel beyond the steam front into the reservoir and into areas not reached by steam due to the presence of steam barriers and baffles. This mechanism has implications for optimal solvent choice, with lighter solvents more likely to demonstrate this desaturation capability over heavier ones but having lower solvent recovery, and heavier solvents less likely to demonstrate this mechanism but having higher recovery. This will be further examined using reservoir simulations in 2015 and will likely impact solvent composition selection for future pilots and the commercial business case.

## Gap Analysis and Next-Pilot VOI Exercise

In early 2014, based on the pilot results from 101-08 and 101-10, an additional single well pair e-SAGD pilot was considered at well pair 101-24. Preliminary scoping activities were completed to identify required facility modifications, plan observation wells, and develop performance predictions for this well pair under e-SAGD operating conditions.

In March of 2014, a gap analysis workshop was held to identify remaining knowledge gaps that could jeopardize the success of the technology and the degree to which those gaps could be closed by various piloting options. The piloting options considered were the single-well 101-24 pilot and a larger “Tech Pad” pilot consisting of

solvent co-injection into 4-6 well pairs. A third option, consisting of both pilots being executed consecutively, was also considered. A value of information (VOI) exercise was completed based on the data gathered during the gap analysis and it was ultimately determined that the 101-24 pilot option offered little incremental value of information compared to the Tech Pad option. It was also identified that the 101-24 well pair contains some unique brecciated zones along the wellpairs, making it an uncertain analog for the rest of Surmont. For these reasons, the decision was made in July 2014 not to proceed with the 101-24 pilot.

**Path Forward**

The primary focus for the e-SAGD pilot in 2015 will be on continued monitoring of well performance and solvent returns. Well pairs 101-08 and 101-10 are scheduled for conversion from gas lift to electric submersible pumps (ESP) in June and July of 2015, respectively. The sampling and monitoring plan is expected to remain unchanged until the team has fully assessed the impact of the ESP conversions on the post solvent injection well performance.

Study work planned for 2015 will leverage the pilot results and the results of the history match and mechanistic studies, and will focus on optimizing operating strategy to maximize the economic performance of e-SAGD. This will include developing an improved understanding of the impact of operating variables on e-SAGD performance, such as solvent composition, injection pressure profile, the tradeoff between solvent recovery and reservoir desaturation in areas not reached by steam, solvent concentration and injection duration, use of flow control devices in e-SAGD well design, and ESP day 1.

## Results – KPI Summary

**Table 1: Summary of key performance indicators for well 101-10**

| Performance Indicator | Cumulative Average e-SAGD Performance |
|---|---|
| Bitumen Rate Uplift(1) | 36% |
| iSOR Reduction(1) | 27% |
| Water Cut Reduction (Absolute)(1) | 6% |
| Average Solvent Concentration(1) | 18% |
| Current Cumulative Solvent Recovery(2) | 39% |

(1) Performance reported for the time period 16 February – 18 August 2013. This period represents the duration of solvent injection at target solvent rates.
(2) Calculated solvent recovery effective until 31 Dec 2014.

**Table 2: Summary of key performance indicators for well 101-08**

| Performance Indicator | Cumulative Average e-SAGD Performance |
|---|---|
| Bitumen Rate Uplift(1) | 26% |
| iSOR Reduction(1) | 14% |
| Water Cut Reduction (Absolute)(1) | 5% |
| Average Solvent Concentration(1) | 20% |
| Current Cumulative Solvent Recovery(2) | 33% |

(1) Performance reported for the time period 14 June – 1 July 2013. This period represents stable performance parameters and is less uncertain relative to the period thereafter which is influenced by unsteady state operations and solvent migration to offset SAGD well.
(2) Calculated solvent recovery effective until 31 Dec 2014. A detailed assessment of pilot data was completed in 2014 to calculate the amount of solvent returned from wellpair 101-09, which is adjacent to wellpair 101-08 and had been producing detectible amounts of solvent since July 2013. This assessment revealed that between 6% and 10% of the solvent volumes injected into 101-08 have been produced from 101-09.

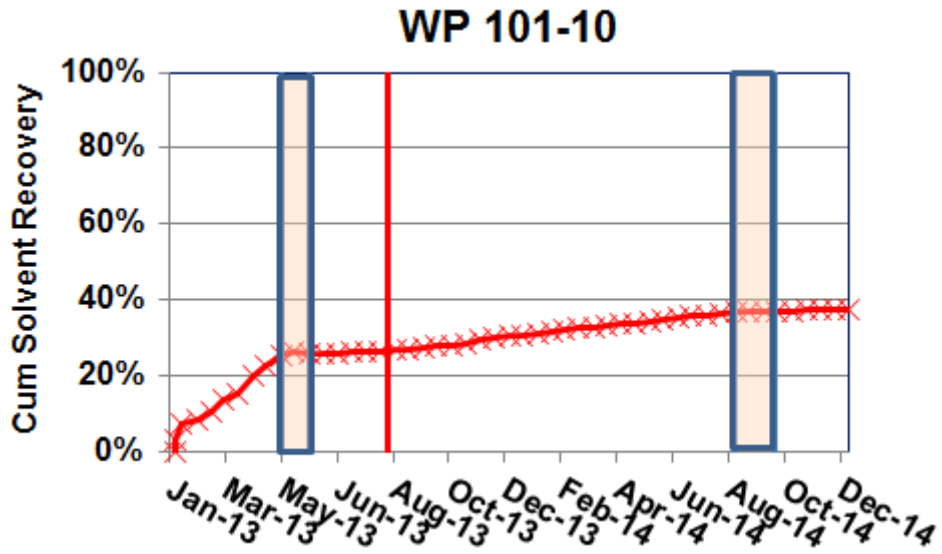


**Figure 1 – e-SAGD Pilot Solvent Recovery (WP 101-10)**

Note: Shaded period to the left of the red line shows interval of off-spec solvent injection. Red line indicates cessation of solvent injection. Shaded period to the right of the red line indicates the 2014 turnaround.

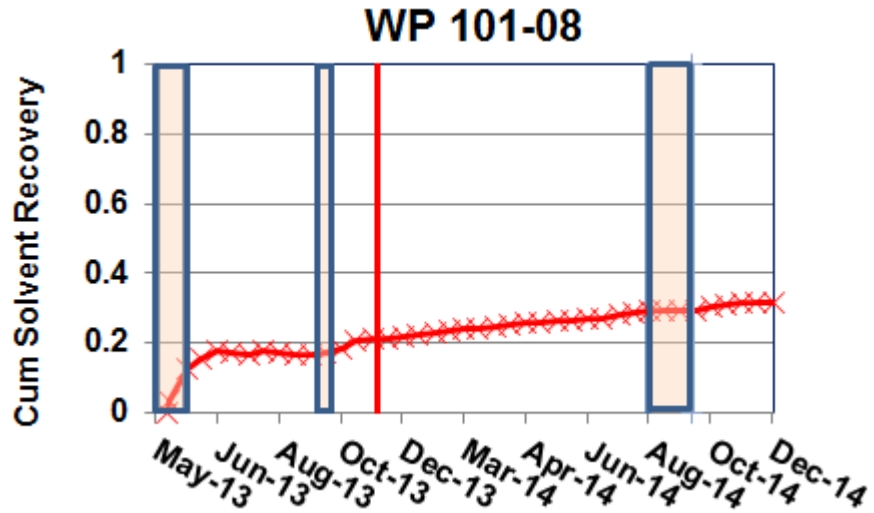


**Figure 2 – e-SAGD Pilot Solvent Recovery (WP 101-08)**

**Note:** Shaded periods to the left of the red line show intervals of off-spec solvent injection. Red line indicates cessation of solvent injection. Shaded period to the right of the red line indicates the 2014 turnaround. Produced gas samples from adjacent SAGD wellpair 101-09 indicated the presence of solvent species since mid-July 2013. Given that 101-09 is not tied into the e-SAGD test system, accuracy of solvent returns from this well is lower than for 101-08 and 101-10.